missiles and rockets

THE MISSILE/SPACE WEEKLY

THE UNIVERSITY OF MICHIGAN
AUG 8 1961
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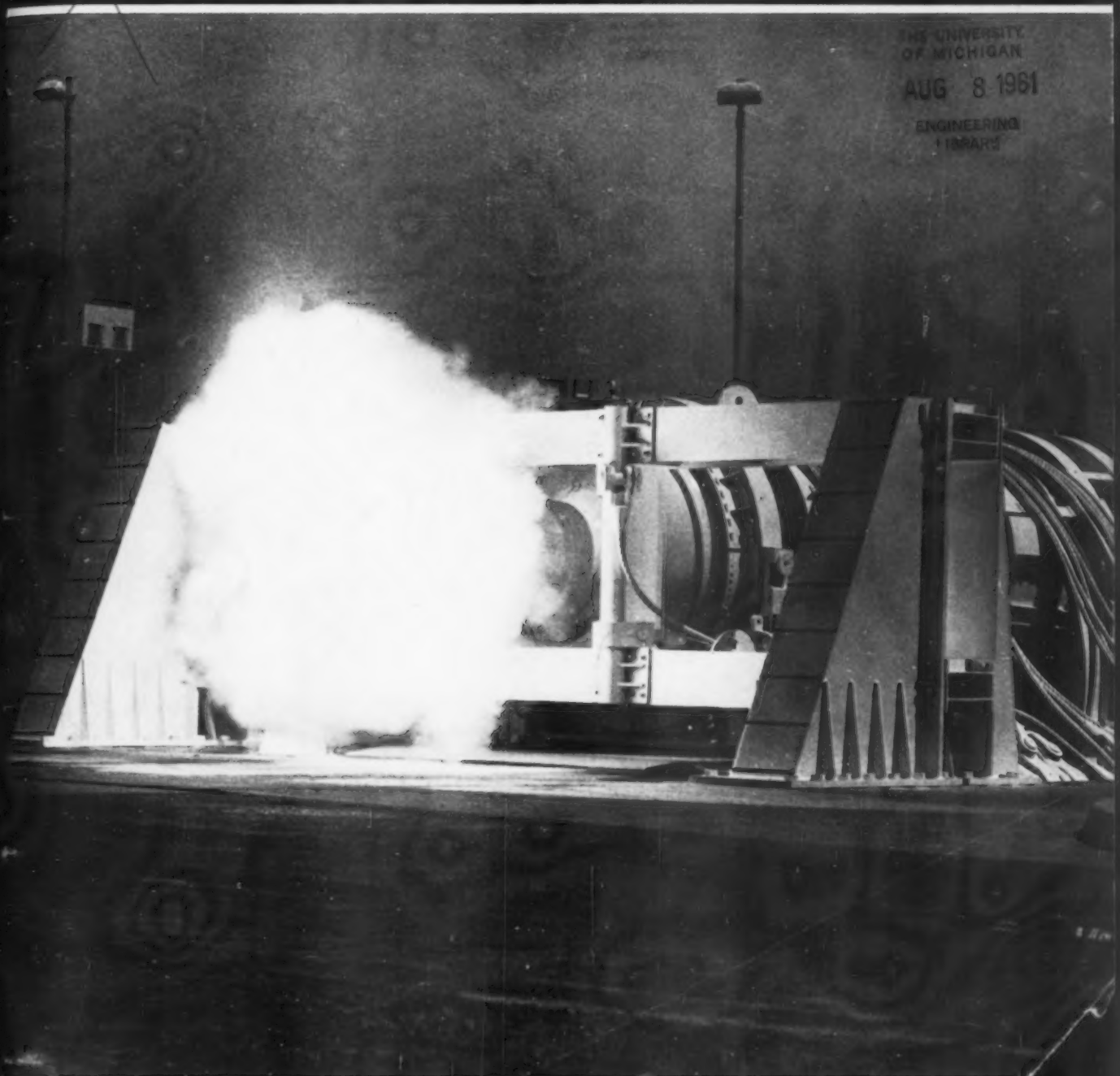

Moment of ignition—Aerojet's big solid motor

Permanent $47 Billion DOD Budget Here

Major Saturn Program Changes on Way..

Blimps for Mercury Ocean Recovery?....

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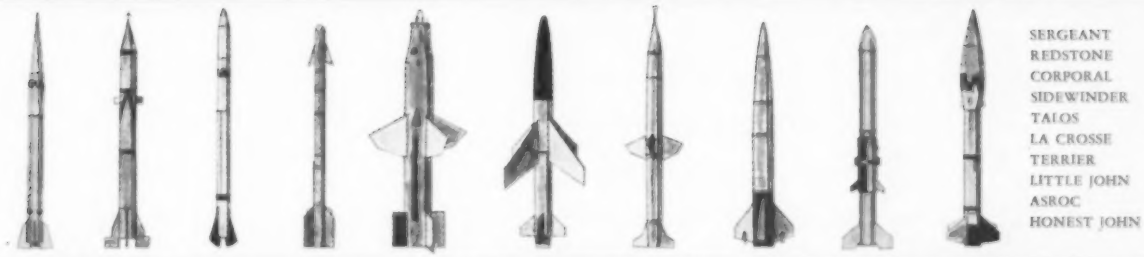
The "Pay Point" of a missile



SERGEANT
REDSTONE
CORPORAL
SIDEWINDER
TALOS
LA CROSSE
TERRIER
LITTLE JOHN
ASROC
HONEST JOHN

From conception through production to detonation, a warhead's successful mission is assured by Honeywell capabilities.

It is obvious that a missile is useless unless its warhead performs properly. The most important consideration is when and where the warhead detonates. Provision must also be made to insure against premature detonation. Honeywell experience has solved these problems for many types of nuclear and non-nuclear warheads. Honeywell warhead systems or subsystems are on all of the missiles shown above.

The Department of Defense conceives a missile to accomplish a specific task. In many instances, Honeywell assists in developing the weapon concept. User requirements are analyzed as the first step in synthesizing a new warhead system. Lethality evaluations are performed on proposed nuclear and non-nuclear kill mechanisms. System criteria are optimized, including economic considerations. A feasibility study is then performed; following approval of the concept by the government, design and development begins. Honeywell technical and management skills can be applied to any or all phases of a warhead system development, from concept to production.

System management of warhead programs is only part of our story. Honeywell has developed and manufactured many types of safing, arming and fuzing components for the three military services and the Atomic Energy Commission. Company and government sponsored programs are now in progress to develop advanced components for future missile and space requirements.

Honeywell's wide experience and management capabilities can assist on your warhead project—from conception to detonation. For more information contact your local representative, or write: HONEYWELL, ORDNANCE DIVISION, HOPKINS, MINNESOTA. *Sales and Service Offices in all principal cities of the free world.*

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MARTIN NUCLEAR ROCKET PROGRAM

REACTOR DESIGN
PROPULSION REACTOR START-UP
NUCLEAR ROCKET SAFETY ANALYSIS
RADIATION EFFECTS ON ROCKET SYSTEM
FUEL ELEMENT DEVELOPMENT
VEHICLE DESIGN
CRYOGENICS

DESIGN OBJECTIVES:

HIGH TEMPERATURE } MAX. THRUST
HIGH FLOW RATE }

STRUCTURAL STRENGTH AT HIGH TEMP.
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- PRESSURE DROP
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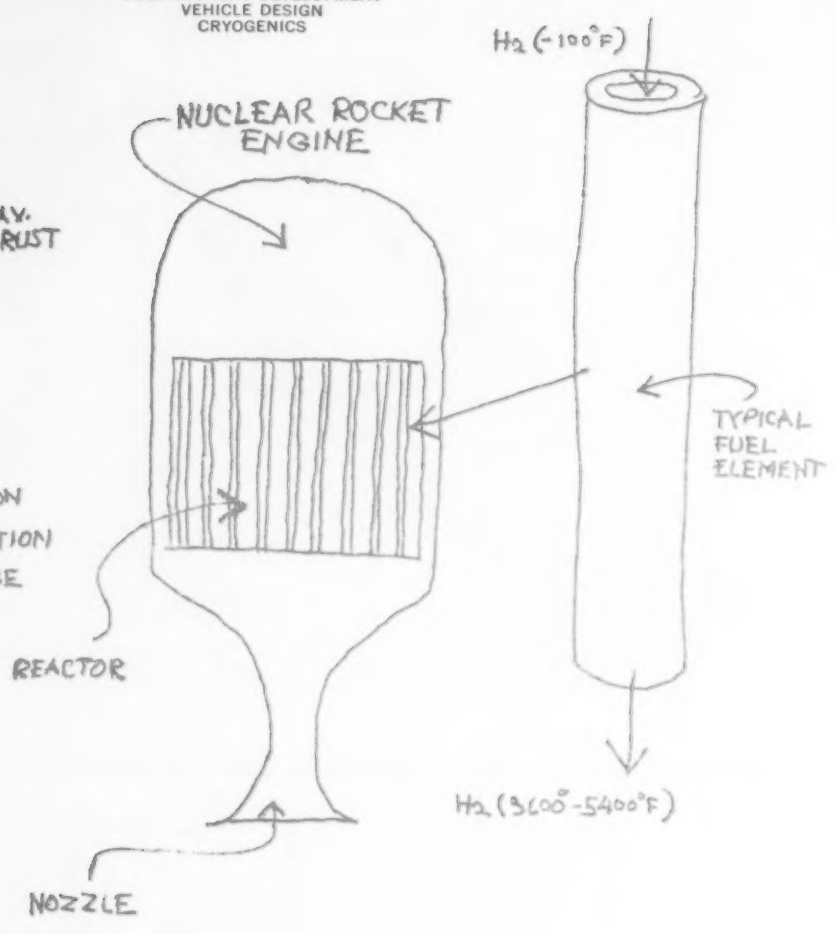
NO HYDROGEN CORROSION
LOW NEUTRON ABSORPTION
MIN. RADIATION DAMAGE



THE PROBLEM OF FUEL ELEMENT DEVELOPMENT FOR NUCLEAR ROCKETS

Nuclear propulsion offers advantages for extended space exploration simply because nuclear energy provides more power per pound than any other power source known. Because fuel element temperatures for rocket reactors may range as high as 5400°F (higher than the boiling point of steel), the limitations of existing materials make the achievement of good fuel element characteristics extremely difficult. Drawing upon its existing materials research and development capabilities and background of producing fuel elements for a variety of reactors, The Martin Company has sponsored an independent program for a number of years directed toward the fabrication of suitable nuclear fuel elements for rocket reactors. This is part of a broad Martin program designed to help meet our national goals of testing the first nuclear flight system by 1966–67.

Test of a fuel element in a plazma jet chamber being conducted at Martin's Nuclear Division.

MARTIN

THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 6 August 7, 1961

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THE COVER

Powerful solid motor springs to life during a recent test firing at Aerojet-General. The 30-ft.-long motor weighs 55 tons, contains nearly 50 tons of propellant. (Aerojet Photo)

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letters

Mach's "Dean Drive"

To the Editor:

It seems really surprising that after 300 years of a successfully grown science of mechanics, the proposed Dean System Drive can cause such an amount of discussion and even confusion.

Beside other remarkable achievements, classical Galilean-Newtonian mechanics is able to provide the necessary physical concepts and mathematical tools to pre-determine the orbits and trajectories of satellites and moon or Venus probes, and mechanical technology, based on these concepts is able to put ballistic objects into these orbits, and this with quite a good accuracy.

Therefore, it should be obvious that some of these classical concepts, for example, the laws of motion—conservation of momentum, action and reaction—and Corollary IV—related to the conservation of the common center of gravity of a system—of Newton's Principia (1686) will be sufficient not only to understand the behavior of the Dean System Drive, but also to evaluate it realistically.

A short investigation of earlier literature related to mechanics confirmed this assumption and, moreover, provided some additional interesting information concerning the drive system in question.

For example, valuable and pertinent information was found in the well-known and quite fundamental book of E. Mach: Die Mechanik in ihrer Entwicklung, historisch-kritisch dargestellt, and especially in Chapter III of this work, bearing the title: "Later applications of the principles of and further developments of mechanics." A word-for-word translation of the German title of the above book is: The development of mechanics, historically and critically presented.

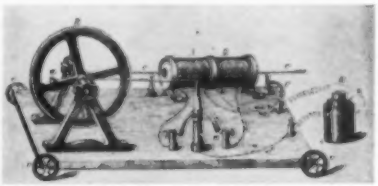
The first German edition of Mach's book was published in 1883. English, French, Italian and Russian translations followed, showing the international appreciation of this work. An American edition with the title: The Science of Mechanics, was published 1902 in Chicago. Very recently, a low-cost reprint of this was made available.

For this letter, the 8th edition, published 1921 and identical with the 7th edition of 1912 was used.

The following text represents a condensation of Section 3 with the title: The laws of the conservation of momentum, of the conservation of the common center of gravity of a system and the law of equal areas. This Section 3 is a sub-division of the before mentioned Chapter III. The below referenced Fig. 150 is given on page 299 of the 8th German edition, 1921. Two photostats of this Fig. 150 are submitted with this letter (see photo).

In this Section 3, Mach considers a steam railroad locomotive, either freely suspended or resting with very low friction on, for example, greased rails. As soon as the heavy masses linked with the reciprocating pistons are set into oscillations, the body of the locomotive is also set into oscillations of opposite sense; this occurs in accordance with the law of the conservation of the center of gravity of the entire system. To avoid such disturbing oscillations of the locomotive's body, it is only necessary to compensate or counterbalance the oscillations of the masses linked with the pistons by arranging adequate counter-weights or masses on the drive wheels of the locomotive.

Mach then adds that this behavior as described by the law of the conservation of the center of gravity of a system can



easily be demonstrated with the reciprocating electromotor of Page, mounted on a carriage provided with the wheels r-r. If the iron core or piston c in the coils A-B is pulled by the electromagnetic forces of the coils to the right or left, the assembly of the electromotor and carriage is forced to the left and right respectively. By arranging a displaceable "inertial" mass (a) on one of the spokes of the flywheel R in such a manner that its motion occurs in opposite direction of the motion of the core (c), the step-like motions or oscillations of the motor carriage assembly can either be decreased or entirely suppressed.

Undeniably, the model shown by Fig. 150 exhibits a striking similarity with the Dean system drive; of course, the Dean arrangement embodies some more sophisticated and refined details. However, in both models the physical "working principle" is basically the same.

The first (1883) edition of Mach's book was not available, however, it can safely be assumed that the prototype "drive system" of Fig. 150 was already shown in the 1883 edition. In his foreword to this 1883 edition, Mach also mentions that all the different demonstration models and apparatus discussed in this edition were laid out by him and built under his supervision in the physics laboratory of the University of Prague.

W. J. Lohninger
Dept. of the Army
Ordnance Corps
Picatinny Arsenal
Dover, N. J.

Non-profit "Truth"

To the Editor:

In reference to your editorial of July 3, *(Thoughts on Non-Profit Firms)* I am

wondering if I can convert you to the way of the meet, the right, and the truth.

I do not know why you should support or defend the so-called non-profit corporations set up by the Air Force, namely STL, SDC and ASC, also MITRE, etc. You certainly are not representing your public by so doing.

You are sacrificing your moral scruples by supporting these organizations and you are doing it simply for the advertising accounts which they have with you. In this regard, I should mention that it is not generally known why these organizations were set up in the first place, and if the reason you gave in your editorial is true—that of providing increased salaries for the privileged few—then your public certainly would not condone this action by the government.

The point is that these corporations are irresponsible. They spend large amounts of money on advertising and publicity which is unjustified. They call it a salary survey, under the guise of recruiting. *This is a fraud.* There is no telling how much the ballot box of job openings has been stuffed, in the minds of your public and the general public, by these so-called "salary surveys." It is fraudulent to pull a fire alarm box, that is, I mean it is against the law. It is also fraudulent to cry wolf when there is no wolf, and it is also fraudulent to offer something for sale (in this case jobs) when there is no job. If you doubt the facts I can tell you that the ones who are doing these activities do not deny what they are doing—they do not deny that they are participating in a gigantic hoax when they carry on this advertising and promotion of which we speak.

I therefore give you the opportunity to clean yourself up by declaring a moratorium in order to look into the facts or to enter a demurrer, in which case you will some day find yourself up against the U.S. Attorney General's office if I have my way.

From your writing I know you to be sensitive to the needs and tempo of our times. By taking a more democratic stand you will be a positive influence upon your country to the extent that you get read or heard through your magazine.

Gene C. Burns
Jackson, Mich.

Redhead Propulsion

To the Editor:

In reference to M/R July 24, page 32, your article on the successful firing of the Redhead/Roadrunner.

It was an excellent article but it does not give credit where credit is due. Without the Marquardt propulsion system, this vehicle would never have made this successful flight. Nowhere in your article do you mention The Marquardt Corporation.

William E. Warner
Advanced Design Dept.
The Marquardt Corporation
Van Nuys, Calif.

(Full marks to Marquardt whose contribution we certainly did not intend to slight—Ed.)

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the Nation.

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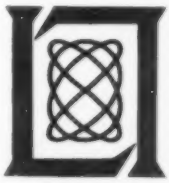
A more complete description of the Laboratory's work will be sent to you upon request.

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.



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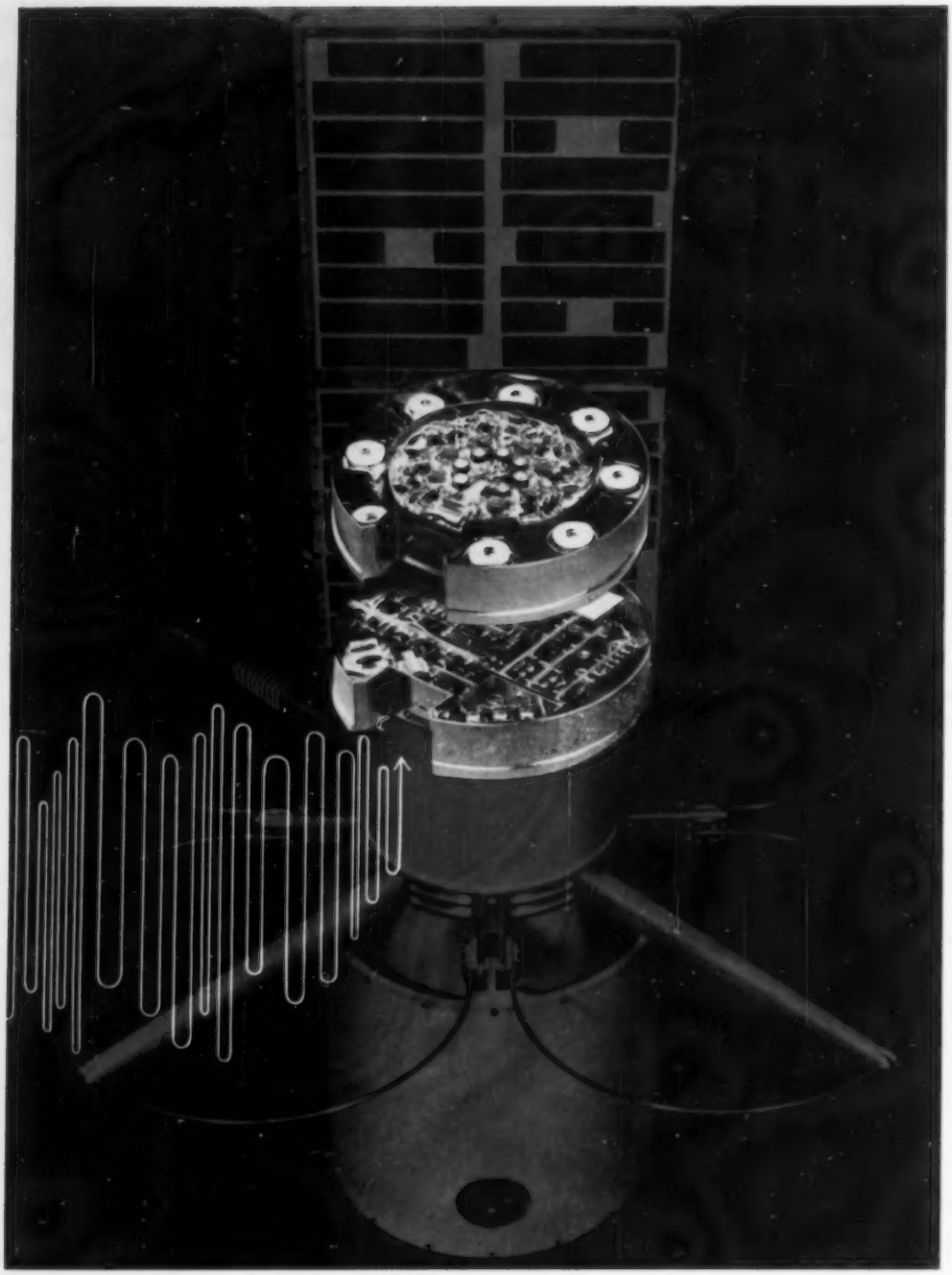

Telling a satellite what to do next. Now in orbit aboard Explorer XI is a uniquely selective receiver. It accepts instructions from NASA transmitters—ignoring stray signals, noise and interference—and relays them to a decoder which instantly actuates the satellite's controls. This receiver-decoder unit, weighing only 3.5 pounds, was designed and built by Avco's Electronics and Ordnance Division.

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The Countdown

WASHINGTON

The Shape of ICBM's To Come

Air Force plans for the configuration of a third generation ICBM are stymied by the continued U.S. temporizing over resumption of nuclear testing. A firm decision on testing resumption one way or the other would vitally affect the specifications for a small ICBM such as the so-called *Midgetman* concept. And a number of military planners says the time for making a decision on a third generation ICBM is already overdue.

Dyna-Soar: More Bird Sooner

The Air Force is expected to use the House-added $85 million for *Dyna-Soar* to try to begin the first sub-orbital flights as much as six months sooner. The money also is expected to be used to tackle some tough phases of the program earlier and thereby purchase extra time to lick any unanticipated problems. Before the increase, the Air Force had planned to launch the first sub-orbital *Dyna-Soars* in 1963-1964.

From ARPA to Sea to PMR

The former deputy commander of ARPA in its greater days—Rear Adm. John E. Clark—is assuming command of the vast Pacific Missile Range. He succeeds Rear Adm. Jack Monroe. Clark has been serving in the Atlantic as commander of Carrier Division 16.

Red Army Strength Challenged

The Defense Department now feels that the Red Army has been overrated. It outclasses the U.S. Army in mechanization and firepower; it also has twice as many men. But, on the Central Front in Europe, the NATO forces are believed to out-man the Russians even without planned increases. (Disclaimer: Those advancing this argument do not deny there are still a lot of soldiers and tanks where the Red Army in Central Europe came from.)

Other Programs Dept.

Officials at NASA are planning to stress the peacetime uses of space and programs other than *Apollo* in their speeches. The reason: Officials fear the public will get the idea that the *Apollo* man-to-the-moon is the agency's sole project.

New Zeus Test Phase Underway

The next-to-final phase in the testing of the Western Electric *Nike-Zeus* anti-ICBM is taking place at Pt. Mugu, Calif. All three of the big missile's stages will be ignited for the first time in flight. Previously, in tests at White Sands, only the first two stages could be ignited because of range limitations.

NASA Rejects Pershing as Booster

Officials at NASA are understood to have rejected a proposal by the Martin Co. to use *Pershing* as a space booster for space probes and small satellites. *Pershing* would be substituted for *Scout* in a number of NASA projects—but agency officials said they saw no overall gain in doing it.

INDUSTRY

Sweetening the Space Net

International communications carriers have a new wrinkle to make their proposed non-profit corporation for operating a commercial communication satellite system more palatable to the government. They plan to allow all international carriers use of the system and engage in any form of traffic desired. The promoters of the plan argue that this would ensure no discrimination among carriers.

More Work Shifts for Industry

The Pentagon policy in expanding procurement orders will be to advocate maximum use of extra shifts and minimum building of new production facilities. DOD expects almost all of the $1.7 billion in new hardware procurement added to the FY '62 budget to be produced within the next year on present assembly lines.

PERT Joins NASA

NASA has adopted the *Polaris* program's famed PERT system to keep track of all of the agency's projects and contracts—including the big *Apollo* man-to-the-moon program. The PERT system used at NASA is somewhat simplified in that only one time estimate for completion dates is being used rather than several as called for by other agencies employing the system.

INTERNATIONAL

And Now Vostok II?

Rumors of an impending new Soviet space shot are being spread in at least three of the world's capitals. The launching is said to be another Soviet man-in-space shot. The manned spacecraft is expected to orbit the earth at least two or three times before landing.

Booming Business at Woomera

Testing at the British-Australian Woomera Weapons Research Range is expanding so rapidly that a major housing program is needed for technicians and workers. The program is scheduled to cost $4.2 million.

The Polariski Subs Were Missing

Western observers especially observed that the Russians did not produce any missile-launching nuclear-powered submarines at the recent Red Navy show at Leningrad. The Soviets have boasted that they now have more of them than the United States. The failure of at least one of the subs to make an appearance increased the belief of U.S. officials that the best the Soviets have so far is a nuclear-powered sub capable of launching only short range missiles.

Ranger Shot Postponed

A rash of technical malfunctions forced several postponements in the scheduled launch of the *Ranger I* lunar spacecraft.

First slated to go on July 26, the technical difficulties raised the possibility that the shot might have to be put off until late this month or early in September.

Lunar shots can only be attempted during the so-called window period when the sun, moon and earth are in the proper positions.

This window period lasts about 8 days a month and has already been exceeded because of the various postponements.

The most serious difficulty which arose was a spurious signal in the spacecraft which killed the Aug. 2 shot.

Two other official postponements were necessitated by a power failure at Cape Canaveral and a ground support problem when a LOX valve stuck, causing a helium leak in the spacecraft.

Besides testing the reliability of the spacecraft, the *Ranger* shot is intended to check out new equipment including an attitude stabilization system based on celestial reference, a high-gain pointable antenna, an advance communication system, the development of components able to operate for long periods and calibration of solar cells in a space environment.

Douglas Realigns for Space Push

ABLE

A major realignment of the Douglas Aircraft Company — designed to strengthen its missile and space potential— was announced this week.

Heading the two newly formed divisions—one for missiles and space and the other for military and commercial aircraft—are Charles R. Able and Jackson R. McGowen, respectively. They have been named Vice-Presidents and General Managers of their respective divisions and will report directly to the President, Donald W. Douglas, Jr.

The new missiles and space division will be responsible for development and production of the *Thor*, *Skybolt* and *Genie* for the Air Force, the *Nike-Zeus* for the Army and the *Saturn S-IV* stage for NASA.

In announcing the changes, Company president Douglas said that "the creation of these two integrated product divisions recognizes the vast growth in the missiles and space field and strengthens us for the future development of aircraft."

RIFT Contracts Awarded

NASA has awarded four firms six month contracts to study design problems involved in flight testing a nuclear rocket engine in an upper stage on a *Saturn* booster.

The firms include Martin Co.'s Denver Div., Lockheed Aircraft Co., General Dynamics Astronautics, and Douglas Aircraft Corp.

Each will receive about $75,000 in government funds. Each will work independently with the studies scheduled for completion by the end of this year.

Last year, both Martin and Lockheed received $100,000 study contracts under the Reactor In Flight (RIFT) program.

While test flight of a nuclear rocket is the primary concern, the new contracts anticipate that data furnished by the RIFT flight test program will have a direct application to operational space exploration vehicles.

Shots of the Week

Vital information on the heating and temperature rates of nuclear power devices during re-entry were collected by the 5000 mile flight of an *Atlas* missile down the Atlantic Range this week.

The Atlas nose cone was designed to eject a pyrotechniques display at 100,000-400,000 feet which could be photographed from Ascension Island to determine what would happen in

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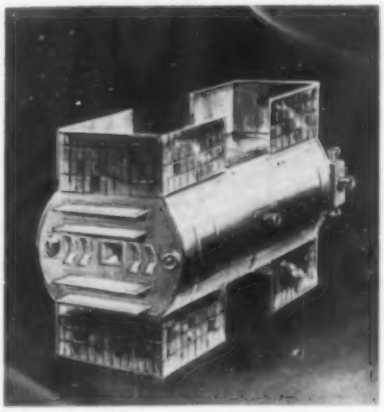

Lockheed ComSat

AN ARTIST'S CONCEPT of a 24-hour, synchronous satellite which could be launched within 18 months was revealed this week by I. Douglas Sailor, a scientist at Lockheed's Missiles & Space Company at the fourth western meeting of the American Astronautical Society. The attitude-controlled, solar-powered satellite would be lofted into orbit by the Atlas/Agena B and a small solid third stage rocket. Sailor predicted an operational vehicle could be available well within four years.

the burn-up of a radio-active generator.

Later tests—using more than 30 separate capsules and different materials—will be used to determine the minimum size and weight of safety devices for nuclear missiles and spacecraft.

The pyrotechniques display in this week's shot consisted of burning sodium and potassium and not actual radioactive materials.

On July 27, a *Minuteman* was successfully fired on a 5000 mile trip but telemetry was lost on the way. This was the third shot for the year with a success in February and a failure in May.

A *Polaris A-2* soared from a pad at Canaveral and went down the Atlantic Missile Range in a successful shot Aug. 2. No range was announced, but presumably the shot went 1400 miles plus.

Goldberg Lauds Base Progress

Secretary of Labor Arthur Goldberg returned to Washington after a two-day trip to four missile bases with members of the President's Missile Sites Labor Commission and promptly praised workers and contractors for the work "being performed with great expedition and great dedication."

Earlier in the week at Cape Canaveral, the first stop on his tour, Goldberg had revealed a letter that the President had written him expressing concern over missile base delays.

"The nation cannot afford the luxury," the President's letter said, "of avoidable delay in our missile and space program." And it indicated strongly that these delays would not be tolerated.

However, on his return to Washington, Goldberg noted that the days lost due to strikes in July had dropped to an all-time low of 209 days—.0002 percent of the more than a million man-days worked.

He noted that problems still exist such as travel pay for workers commuting long distances each day, inadequate housing and jurisdictional problems arising from the complexity of the missile programs. These, he hopes, can be solved by the cooperation of both the unions and the contractors with the Missile Sites Labor Commission.

The Labor Secretary's 6700 mile inspection tour took him to Cape Canaveral, Strategic Air Command Hq's at Omaha, Vandenberg AFB and Mountain Home AFB in Idaho.

Anderson Takes Over as CNO

Admiral George W. Anderson became the new Chief of Naval Operations this week, replacing retiring Adm. Arleigh A. Burke.

One of Anderson's first actions was to dispatch a message to naval units throughout the world assuring them that he would keep the Navy "on course and steaming strong."

Anderson in the past has been rated as a close associate of the now fading "New Look" of the Eisenhower administration.

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taylor's thesis . . .

New DOD Budget Level Fixed at $47 Billion—or Higher

Latest Kennedy strategy aimed at opening up use of limited war forces for Cold War political jockeying; military commanders get 'options' with NATO division buildup

by James Baar

THE NEWLY-revised Kennedy defense budget is designed to prepare the way for the nation's limited war forces to go on the offensive in the political Cold War.

This fact became clear this week as the $47 billion military budget moved swiftly through Congress and Soviet Premier Nikita Khrushchev continued to make threatening noises and gestures over Berlin.

Three other important aspects of the new budget that also became clear were:

—The United States is seeking to expand the number of NATO divisions on the Central European front from 20 to 30. More U.S. troops will be contributed; the European NATO allies are expected to do likewise.

—The United States has no plan to rely solely on non-nuclear forces should war break out with the Soviet Union.

—The new budget level of $47 billion probably will become a Cold War fixture for the foreseeable future. And if the Berlin situation worsens the figure would go up.

Congress completed passage Aug. 3 on the increased military authorization bill for missiles, planes and ships and sent it to the White House. The $13.5 billion bill included the extra $1 billion President Kennedy requested only a week before.

Meantime, Congress neared final action on the expanded $46.8 billion military appropriations bill. As it cleared the Senate Appropriations Committee, this bill included not only all of the extra $3.5 billion sought by Kennedy in his new requests but also $525 million for big bomber procurement and $228 million more B-70 R&D unsought by Kennedy.

• **Option Power**—Acting Chairman A. Willis Roberston of the Defense Appropriations Subcommittee said the "committee felt we could not put our entire dependence on long-range missiles." Other congressmen previously have insisted that the extra bombers also will be needed as carriers for the 1000-mile range *Skybolt*.

However, the Administration continues to stand firm in its determination not to spend the additional bomber money.

The new plan for the nation's Armed Forces that is now unfolding is based on what the Pentagon top civilian command refers to as the doctrines of "conventional option" and "controlled response."

What this means essentially is the final junking of the old doctrine of "massive retaliation" espoused by the Eisenhower Administration in favor of forces that permit a greater variety of military action. But it does not mean that the Kennedy Administration is preparing to refight World War II.

The forces that Pentagon plans now call for will enable field commanders to have a considerably wider option in taking military action. Also these forces will enable NATO and the United States to combat—and possibly engage in—the kind of military jockeying of power that has enabled the Soviet Union to wage political aggression throughout the world.

Among other things, the increase in limited war forces will enable the United States to mount a realistic airlift to Berlin if desired. The increase also opens the way for a far greater mobilization in short order if one is needed.

• **Familiar refrain**—The Pentagon's new plans are said to be a result of the extensive studies which have been conducted over the last six months. However, they also significantly parallel much of the thinking of the President's new personal military adviser, Gen. Maxwell Taylor (ret.).

Taylor, who as Army Chief of Staff bitterly opposed the doctrine of massive retaliation, has called his substitute for it the "National Military Program of Flexible Response." The "conventional option" and "controlled response" have much in common with the "flexible response."

Whatever name they go by, the new plans will mean considerably more military spending than under the Eisenhower Administration. If only the new force levels are made permanent giving the Army two or three more divisions, the defense budget is expected to remain at $47 billion.

The possibility of reduction in any key area is slim. Some of the big missile programs—*Titan* and *Atlas*—are nearly purchased. But *Minuteman* and *Polaris* even without possible new increases are expected to cost billions more; military space programs are expected to cost increasingly large sums; and the deployment of the *Nike-Zeus*—a Taylor favorite—would cost $8 billion alone.

Moreover, some of the costs of increasing the nation's limited war forces such as keeping the Fleet from slowly falling apart have yet to be touched.

A budget of $47 billion probably is conservative. One expert of increasing stature in the capital these days put the price tag at $50 to $55 billion nearly two years ago and warned there was little time left to act. The expert's name is Maxwell Taylor ¤

part of speedup . . .

NASA Dropping Saturn C-2 Booster

Up to 20 C-1 vehicles will be built—15 by industry; more changes are coming in race for the moon

by Hal Taylor

A 50-TON minimum weight specification for the *Apollo* lunar spacecraft is prompting NASA to discard plans for the "middleweight" *Saturn C-2* booster. The agency now intends to jump directly from the *Saturn C-1* to the *Saturn C-3*.

The switch is intended to expedite development of the *C-3* booster which also may be upgraded from 3 million lbs. thrust to 4.5 million lbs. by the addition of a third F-1 engine.

NASA officials believe the change will make it possible to have the *C-3* operational by late 1965 or early 1966. This time scale could put the United States in a more competitive position with Russia for a 1967 landing of an expedition on the moon.

The three-stage *C-2* was designed to either earth orbit 45,000 lb. or boost 15,000 lbs. to escape velocity. This would have been sufficient only for earth orbiting a 12,500 lb. *Apollo* command module and a space laboratory which apparently now has been sidelined for the main assault on the moon. New plans also call for a heavier command module, perhaps 20,000 lbs. or more.

Reshuffling of *Saturn* now indicates that NASA might be able to follow this optimum *Apollo* flight plan:

—Manned earth orbital flights of the three-man capsule about 1964-65 using *Saturn C-1*.

—Lunar orbit of the command capsule plus a propulsion module in late 1966 or early 1967 using *Saturn C-3*.

—Rendezvous experiments with *Saturn C-3* in high orbits in the 1965-67 period.

—Attempt at a lunar landing launched from orbit or a direct flight from earth using a *Nova* superbooster, possibly in late 1967 or early 1968.

• **Weight not set**—Projection of flight schedules much beyond *Saturn C-1*, however, is still very nebulous since the weight of the *Apollo* spacecraft still is not frozen, nor the multitude of design problems overcome.

NASA officials estimate that once the *Apollo* achieves escape velocity it will need a propulsion capability 12 times its own weight to effect a lunar landing and takeoff.

If the *Apollo* lunar vehicle weighs somewhere between 50 and 75 tons (see below), a rendezvous refueling technique is seen necessary using an uprated *Saturn C-3* as the primary booster. The parallel development of 9-12 million lb. thrust liquid or solid *Nova* vehicles, to be launched under the FY '62 budget by NASA and the Air Force, could avoid this complicated step—if *Nova*

(Continued on page 45)

Competition Starts for Building 50-75 Ton Apollo Spacecraft

NASA OPENED the competition about a month early last week on the multi-million-dollar contract to build the *Apollo* lunar spacecraft.

At the same time, it was disclosed that new specifications call for a lunar spacecraft weighing from 50 to 75 tons total. The command module alone may scale from 10 to 20 tons.

Bids are due by Oct. 9 with a prime contract award expected about January.

Firms asked to submit proposals include Boeing, Chance-Vought, General Dynamics, Douglas, General Electric, Goodyear, Grumman, Lockheed, Martin, McDonnell, North American and Republic Aviation.

The spacecraft—designed to carry three men to the moon and back—will not have wings, but it will be a lifting vehicle.

Some aerodynamic lift is needed so that it can maneuver through the atmosphere on re-entry.

As a result, the L/D ratio will be somewhere between .5 and 1. The lift surfaces are necessary to permit the spacecraft to hit a recovery area on return to earth that has been established

Martin Co. Apollo concept

at about 3000 miles long and 500 miles wide.

With the spacecraft's weight at escape velocity estimated at 100,000 to 150,000 lbs., NASA officials said roughly one third of this will return to the earth.

The Command Module will be 13 to 15 ft. wide and about 12 ft. long. Total length of the spacecraft including escape tower, booster facilities, and air lock is estimated at 55 to 60 ft. long. Final dimensions will be determined by the winning contractor.

Recovery will probably be by parachute, but the Space Agency is conducting, along with several private firms, studies of the flexible wing recovery technique.

There are no present plans to include atomic powered batteries in the spacecraft. Instead, the contractors have been ordered to investigate and consider solar cells, fuel cells and motor generator sets.

Apollo will also have the same basic systems as the Project *Mercury* spacecrafts including an environmental control system, a communications system and guidance and control. All of these will be much more sophisticated than that carried on the Freedom 7 or Liberty Bell 7 capsules.

Specifications for the spacecraft were prepared by NASA following feasibility studies by Martin, Convair, GE, and the Space Agency itself.

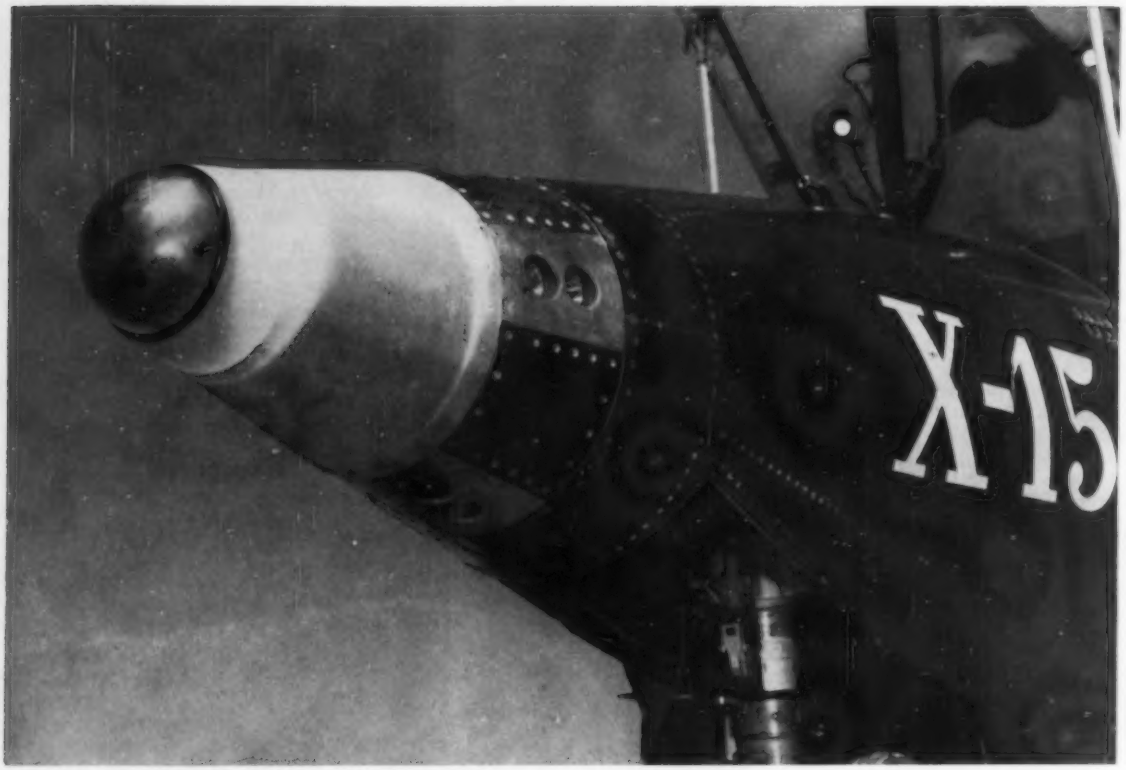
Contract for *Apollo* will be awarded late this year or early in 1962. ¤

with modifications . . .

Dyna-Soar 'Picks-off' X-15 Hardware

Space Bomber will adopt some concepts, inertial platform to be most direct "steal"

by Bill Wilks



NEW BALL NOSE of X-15 may go aboard Dyna-Soar.

EDWARDS AFB, CALIF.—*Dyna-Soar* will pick off major subsystems and concepts developed in the *X-15* program, including the ball nose, inertial platform, ballistic controls, stability augmentation and side-arm controller.

The National Aeronautics and Space Administration Flight Research Center here, reports the *X-15* also is being used as a test bed for concepts applicable to a variety of vehicles including the B-70, *Aerospace Plane, Apollo,* supersonic transport and low-level attack aircraft.

"But *Dyna-Soar* hardware will look more like the *X-15*'s than will that of the others," says Jim Love, NASA *X-15* project manager. *Dyna-Soar* also will benefit from features of the *X-15*'s landing gear, structure and materials, pilot and ground handling techniques, pilot's environmental system, auxiliary power units and pilot's biomedical monitoring program.

"When I say, 'pick off,' I don't mean a particular item will be used 'as is,'" adds Love. "Modifications are necessary, and the state of the art keeps improving. The ball nose is an example of this."

• **Unique nose**—Pocked by five holes of about ¼-in. diameter to obtain air flow information, the ball rotates on the *X-15* but probably would be fixed on *Dyna-Soar*. There still is some question as to whether the ball nose developed by Nortronics division of Northrop Corp., will go into *Dyna-Soar* since there might be a problem of the orifices fusing over with ceramic material during re-entry heating. Studies are underway to determine the best materials to meet this problem.

In *Dyna-Soar* the ball would be fixed to avoid the complexity involved in the hydraulic and servomechanisms required to rotate it. It probably would be ceramic-coated. The *X-15*'s is uncoated.

With a fixed ball, some type of onboard computer will be necessary to calculate the pressure differentials across the holes, figure out the angle of attack and convert it to a pilot display.

Dyna-Soar re-entry will not be as critical as that for the *X-15*. It will be able to absorb heat at a higher rate because of its material and construction.

In the North American Aviation rocket vehicle, the nose ball takes over

(Continued on page 44)

in ComSat case . . .

NASA Stakes Out New Licensing Policy

Space Agency claims new plan is necessary to prevent satellite communications monopoly in launch contract with AT&T

NASA has established an "open door" license policy in cooperative ventures with private industry.

In a contract signed last week to launch up to four American Telephone & Telegraph-owned experimental communications satellites, the space agency staked claim to royalty-free license rights on all new technological developments achieved by AT&T in building the satellite system. NASA also retains the power to assign these same rights to any other commercial firm it chooses.

Officials indicate, moreover, that the same provision may be written into future contracts where NASA performs certain services for private enterprise.

The explanation for the new policy given by NASA is that it needs these rights to prevent any one firm from monopolizing the space communications business.

Signing of the contract was announced as NASA released more details of its Project *Relay* communications satellite, which will be built under a $3 million contract with Radio Corporation of America. In other ComSat developments:

—The House Small Business Anti-Monopoly Subcommittee ordered the Federal Communications Commission to appear this week on the commission's plans for a privately owned ComSat system.

—The eight-member international communication common carrier *ad hoc* committee held its first organizational meeting. The committee has been ordered to prepare plans for a privately owned system by Oct. 13. The companies reportedly are leaning toward a non-profit corporation which would lease circuits to any communications carrier desiring to use them.

NASA officials contend that neither Project *Relay* nor the contract with AT&T represent a government attempt to control the communications satellite system. They said that both steps are necessary to advance research and development leading to a worldwide system.

Although very similar, Project *Relay* and the AT&T satellites differ in one important respect.

• **Contract details**—The AT&T satellites will receive signals from ground stations at a frequency of 6390 mc, about three times the frequency of 1725 mc used by *Relay*.

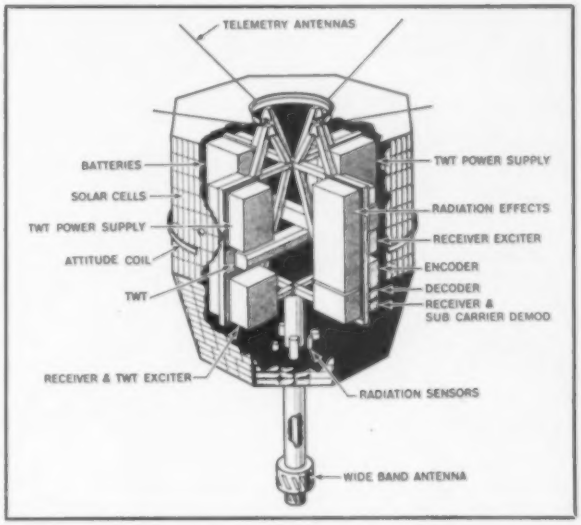
AT&T feels that the ultimate operational system will perform better and have greater capabilities at the higher frequencies.

Under the contract NASA will launch two AT&T satellites in April and October 1962. The firm can also exercise an option to launch two backup satellites in June and December. It is estimated that each firing using the *Thor Delta* booster will cost the space agency $6 million.

AT&T will design and build the satellites at its own expense and will reimburse NASA for the costs of the services and facilities which it provides including launching and range tracking.

The AT&T satellites will be spherically shaped and will weigh 125 lbs. each. They will be launched into elliptical orbits approximately 600 miles from the earth at perigee and 3000 miles at apogee. Inclination to the earth will be 45 degrees. Their power supply will be nickel-cadmium storage batteries.

Wideband communications experiments—television, two way telephone, radio and telegraphy—will be transmitted between the AT&T ground stations located at Rumford, Me. and Holmdel, N.J., via the satellites.



CUTAWAY of NASA Relay satellite

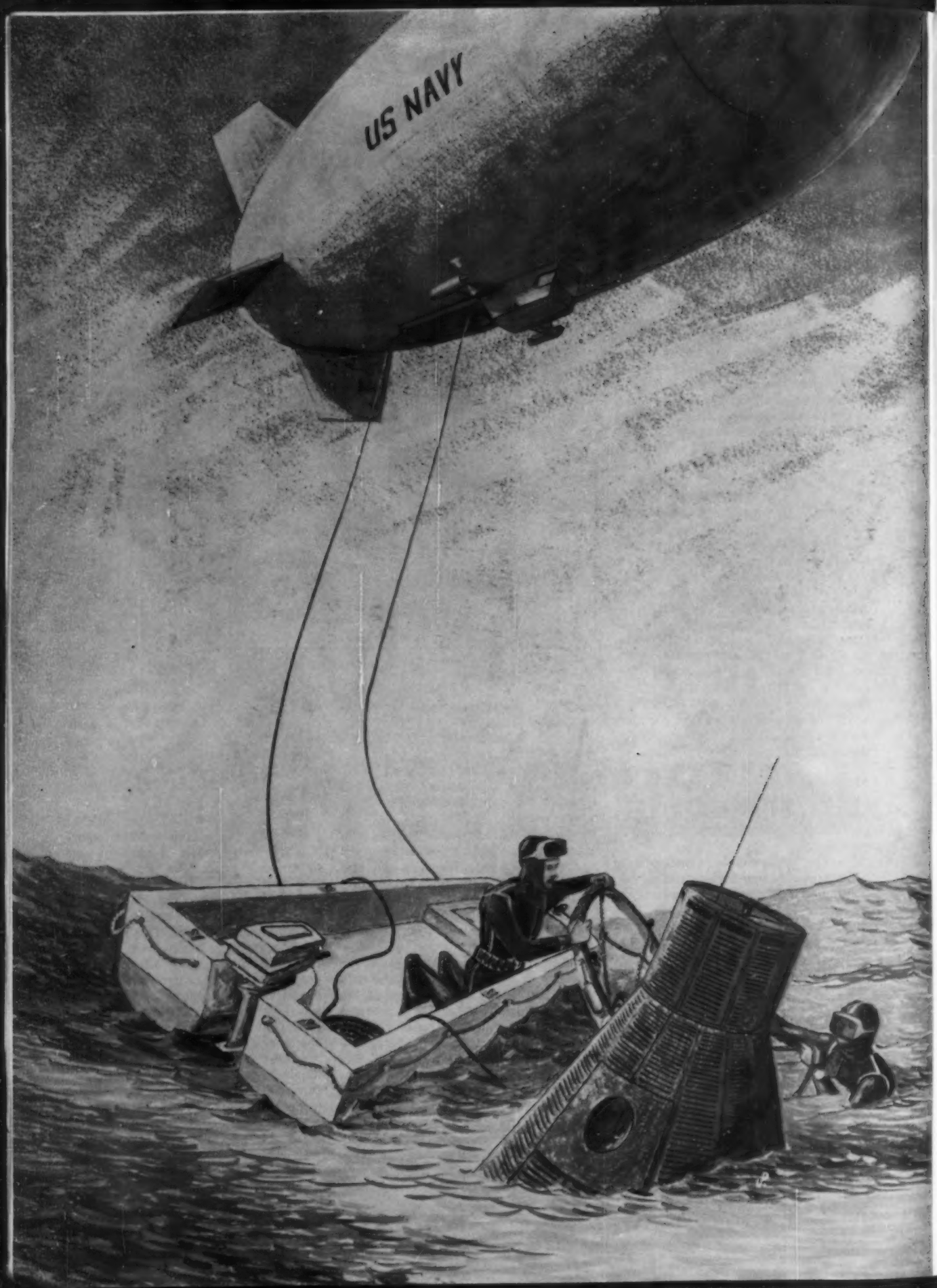
• **Relay details**—The eight-sided *Relay* satellite, weighing approximately 100 lbs. will be launched by a *Delta* rocket from the Atlantic Missile Range in 1962. The orbit will be elliptical, with a perigee of nearly 900 miles and an apogee of 3000 miles. The equatorial inclination will be approximately 48 degrees.

Somewhat barrel shaped, the satellite will be 26 in. in diameter and 29 in. high, excluding antennas. Power for the spacecraft equipment will be furnished by some 6000 radiation protected solar cells mounted on the sides.

For greater reliability, the satellite will contain two communications transponders, each capable of receiving and transmitting either television, two way telephone, or other forms of wide-band data. Ground command stations will select the transponder and its mode of operation for any given transmission.

The transponders will receive the transmitted information from the ground on a planned frequency of 1725 mc. After the transponder amplifies the signal, it will be retransmitted to the ground at a frequency of 4170 mc by a special 10-watt traveling wave tube.

Other instrumentation in the satellite includes two command control receivers and decoders which will be used to operate the electronic equipment via a radio control link from the NASA Minitrack network and a pulse code telemetry system to transmit performance data on the satellite's equipment and radiation experiments. ⌗


US NAVY

Mercury Rescue: Mission for Blimps?

new technique proposed to save astronaut and capsule

but Navy is cool to LTA buffs seeking new space role for airships

by William E. Howard

LIGHTER-THAN-AIR buffs in industry are trying to pump new life into the all-but-extinct blimp. They believe available Navy airships are the best means of rescuing *Mercury* astronauts from the sea.

Several arguments are being advanced to the Navy:

—A blimp has the lifting capacity to pull even a water-filled *Mercury* capsule from the ocean.

—ASW blimps now in the process of being discarded by the Navy could replace the carrier and some of the surface vessels now being tied up by the *Mercury* program and release them for combat duty in the Berlin crisis.

—Use of an airship would remove any problem caused by downwash from a helicopter hovering over an astronaut floundering in the water.

—Sea rescue by blimps were effected repeatedly in World War II.

These points were raised this week following the loss of the Liberty Bell 7 capsule, which sank in 2800 fathoms of water at the end of the *Mercury-Redstone* flight July 21. Loss of the capsule, which filled with water when an escape hatch blew out prematurely, was attributed to a faulty engine indicator light in the helicopter trying to recover it. The pilot cast off the weighted capsule when he thought his engines were overheating.

Astronaut Virgil Grissom, who was hauled to safety by a second 'copter, later said he was bothered by the downwash of the helicopters circling overhead. He had difficulty struggling to reach a rescue harness as his spacesuit rapidly filled with water.

There has been consideration of employing larger helicopters—but this only magnifies the downwash problem. The Navy, which is in charge of the recovery operation, in any event has limited the helicopter size to those which can be deployed from an LSD (landing ship dock) deck in case a carrier is not available.

• **Navy cool**—Although some industry sources claim the Navy once ran a study showing blimps could perform the *Mercury* rescue-recovery mission, the Navy now says it does not consider them feasible. The reasons:

DETAIL of hoist from sea to blimp.

—Blimps lack the necessary maneuverability and hoverability for hooking on to a capsule within a safe time limit.

—Time needed to get a blimp ready to fly is too long when considered along with the start-stop problem inherent in a launch attempt.

A plan being pushed by industry, however, would overcome the first objection by lowering a fibre glass and foamed aluminum boat containing two frogmen to the capsule (see artist's conception opposite page) thus eliminating the need for hook-on hoverability. They would rig an inflatable rubber ring below the hatch line of the 9.5 ft. capsule to keep it afloat while the astronaut disembarks.

The same rigging would be used to lift the capsule to the airship, or hold it for recovery by surface ships.

The astronaut would be hoisted to the airship gondola which could be outfitted with medical equipment and doctors to give him emergency treatment or post-flight examinations. (The boat itself would be part of the floor of the gondola.)

On the second point, the airship proponents maintain that the unrefueled endurance of an airship is two days (against a few hours for a helicopter.) They contend, moreover, that the 45-knot speed of a blimp—about half that of a helicopter—would be ample if two, or more blimps were assigned to patrol the recovery area for an orbital *Mercury* flight.

NASA expects a *Mercury* capsule returning from three orbits to impact somewhere in a strip of ocean about 600 miles long off Puerto Rico. High speed aircraft and helicopters presently are planned for unmanned orbital shot due in the next two months.

• **LTA controversy**—Another advantage cited for the blimp is that two or three positioned over the predicted impact area could carry the electronic gear to track the reentering capsule.

But the prospect of these and other arguments making any headway appear dim. The last of the ASW blimp fleet is being dismantled at Lakehurst, N.J. All but two ships, which will be retained for ASW research, are being decommissioned.

The personnel at Lakehurst are being disbanded. The whole operation will wind up in October. Unless moves are undertaken speedily, there is little chance that the blimp fleet can be kept intact.

Many in the Navy are saying farewell with relief. The Atlantic fleet never has shown great enthusiasm for blimps, despite their record of usefulness in World War II. Today, many officials are inclined to look at sausage-shaped airships as little more than outmoded—and expensive toys.

LTA buffs feel the critics are unfair. They have advanced plans to carry *Saturn* boosters from their manufacturing plants to their launch pads and suggested many other chores for the blimp in the Space Age.

They claim the blimp has a lot of life left. They just want a chance to prove it with *Mercury*. ¤

A cross-section of the 40 subsystems incorporating 3500 electronic parts which go into TIROS III are framed by two satellites. All components must be thoroughly tested, precisely integrated and must function perfectly if the satellite is to perform successfully.

NASA's Hurricane spotting TIROS III maintains projects' fine performance record

With the successful launching of TIROS III, meteorologists for the first time will see the total cloud formations and measure the radiative energy balance of hurricanes which plague the eastern coast of North and Central America each year. For TIROS III was launched at this time for precisely this purpose. From information gained from TIROS III, meteorologists may learn much more about the birth and life cycle of tropical storms.

TIROS III DESIGN

Although the spacecraft configuration is essentially the same as the previous two highly reliable TIROS satellites, TIROS III has two wide-angle cameras and the National Aeronautics and Space Administration has placed new omnidirectional IR sensors aboard to measure thermal radiation from the earth and sun.

THIRD OF A FAMOUS FAMILY

TIROS III is the third of a highly successful series of experimental weather satellites which were developed, along with the associated ground equipment, for the NASA, under contract with the Goddard Space Flight Center, by RCA's Space Center. All of them have established "firsts" in the United States' space program.

TIROS II established a longevity record for a complex satellite. Still operating after nearly eight months and over 3300 orbits, TIROS II has transmitted over 34,000 photographs to the ground. Aside from its impressive meteorological achievement, historians may well point to this long-term performance as the first to prove that a satellite system could operate reliably for so many months in a space environment thus proving the feasibility of operational satellites.

TIROS I was the first satellite, carrying advanced television equipment, which sent photographs of the earth's cloud cover to meteorologists. From TIROS I's 23,000 photographs, meteorologists found that satellites could be used for weather observation and analysis. The pictorial information is particularly useful in the two-thirds of the world from which few or no weather observations are now available.

CONNOTATIONS FOR THE FUTURE

The TIROS series has proved beyond a doubt that the peaceful uses of space will benefit all mankind. Six nations participated in the utilization of information from TIROS II and more will take advantage of TIROS III. RCA is also already at work on the camera systems and space power supply for NIMBUS, the next generation of meteorological satellites.

If you are a professional physicist, engineer, or mathematician and interested in participating in such challenging projects and stimulating team efforts, contact the Employment Manager, RCA Astro-Electronics Division, Defense Electronic Products, Princeton, N. J. All qualified applicants are considered regardless of race, creed, color or national origin.

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Technical Countdown

ASTRONAUTICS

Able-Star Breakup Still a Mystery

The unexplained operation of the destruct system initiating detonation of the unused hypergolic propellants in the tanks is thought to have caused the break-up of the *Able-Star* upper stage which launched *Transit IV-A* on June 29. A battery in the destruct system was kept alive for the first time in a test of battery life expectancy and, for this reason, there was no automatic short-out of the destruct system. Another conjecture—admittedly unlikely—is that an impacting meteoroid caused the tanks to detonate.

Loss of Muscle Tone a Problem for Astronauts

Bioscientists—studying the problem's of man's adaptability to space—have concluded that one of the major problems for future astronauts will be the loss of muscle tone from living without gravity. Extrapolating from the body's reaction to long periods of inaction—such as long confinement in a hospital or floating in water the scientists found that under such conditions man's tolerance to stress, temperature, acceleration or tilting was reduced.

AEC Radiation Dosages Inapplicable to Space

A study—conducted by the Martin Co. as part of the *Apollo* program—indicates that man in space may be required to endure short term radiation dosages much in excess of recommended AEC levels. Based on an accumulation over a 45-year working life, the AEC levels call for an average of 5 rem per year plus an emergency dosage of 25 rem. More applicable, says the Martin study, would be the figures and effects used by civil defense planners. These describe emergency doses of radiation of 100-200 rem.

PROPULSION

Spark Plugs Make Space-Age Comeback

Aerojet-General, Sacramento has returned to an early method of starting rocket engines. Spark plugs have been used for over 20 starts (with the same set of plugs) with many starts of over 20 secs. duration. One liquid rocket was fired seven times in a short period without changing the plugs in order to demonstrate a restart capability for space vehicles.

Able-Star II Work Started

Initial work is underway on *Able-Star II* at Space-General. This newest restartable configuration—scheduled for future space missions—will be able to orbit a larger payload than *Able-Star I*. It uses a higher thrust engine and an all-new ablative thrust chamber. The LOX-Hydrogen *Star II* will provide an upper stage for either the *Titan* or *Atlas*.

X-15 to Have Greater Throttling Capability

The *X-15*'s large engine is being modified to enable throttling from 30 to 100 percent thrust, thereby increasing its flight profile for test purposes. The XLR-99 engine is presently capable of 50-100 percent throttling—from 30,000-60,000 lbs. thrust. With the modification, thrust can be varied down to 16,000 lbs., thus filling the gap created when the *X-15* switched from the two 16,000 lbs. thrust engines. First flight with the modified engine is scheduled for September.

SUPPORT EQUIPMENT

Fast Loading System Developed for Silos

A loading system—capable of "dropping" *Atlas* ICBMs into a silo in 13 mins.—has been developed by General Dynamics/Astronautics. The "mobile silo missile erector" is trailer-mounted with a self-contained power supply. It can erect an *Atlas* for lowering into a silo in up to 60 mph winds.

F-100 Used to Study Spacecraft Landings

The Air Force has modified an F-100F Super Sabre in a program similar to that conducted with an F-104 at Edwards AFB for development of spacecraft landing techniques. Simulating the landing of a boost-glide vehicle, the F-100 lands at 230 mph without power and approaches at a very steep angle. The program may determine the length of runways required for landing of *Dyna-Soar* type vehicles.

Precise Timing Device Installed at PMR

A centralized system to automatically record the exact timing in missile launch operations is being installed at PMR headquarters. The electronic system marks film and tape records of launches with the exact day, hour, minute, second and tenth of a second through use of a timing generator sending out 100 electronic pulses of varying widths every second. The pulses are put on the film or tape records of a launch and, by comparing the pattern of the pulses against a master tape, it is possible to determine the exact time of a particular event.

MATERIALS

Cryogenic Nuclear Studies Launched

Neutron absorption scattering cross section of hydrogen at cryogenic temperatures will be investigated by Astra, Inc. in cooperation with North Carolina State College under a NASA contract. First phases will be theoretical with experimental designs following. Studies will have direct application to nuclear rockets.

Solar Energy Converter Studies Extended

Development of a solar energy converter will be extended another year at National Research Corp. under a $79,800 Air Force contract. The lightweight unit is based on the theory and designs of Professor T. Gold, Cornell University, NRC consultant.

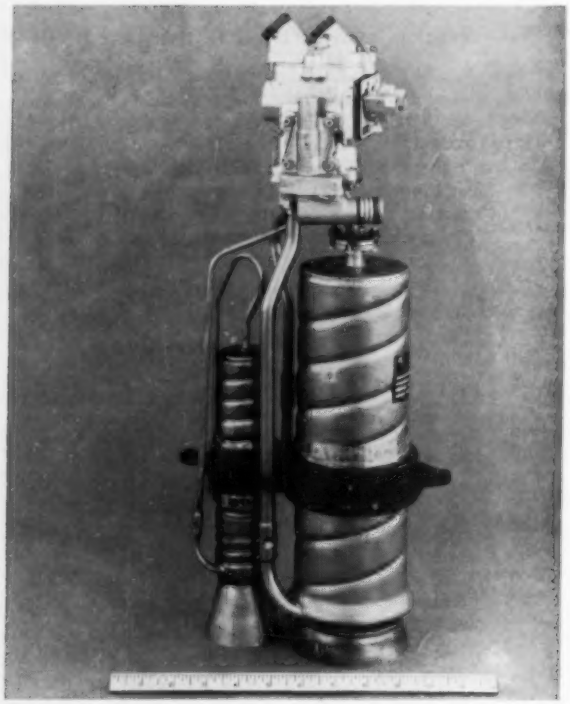
Cosmic Ray Experiments Scheduled

The Navy plans to launch 12 large balloons from Fort Churchill to measure the charge distribution and the energy spectrum of the heavy nuclear components in primary cosmic rays. The flights are part of the Navy's Project Skyhook. NASA will foot the bill for 11 shots and the Office of Naval Research picks up the tab on one.

Compact Engine Boosts Navy Target Drone

Liquid rocket being produced by Rocketdyne weighs only 17 lbs., produces 685-lb.-thrust for Beech's XKD-2B-1—a Mach 2 target which soars to 70,000 ft. in 22 seconds

by Frank G. McGuire



SEVENTEEN pound P-4 engine uses storable fuel, and is only 18.5 in. tall. P4-1 is slightly larger.

CANOGA PARK, CALIF.—A compact, mass-produced liquid rocket engine has been developed by Rocketdyne to boost the Navy's latest target missile to 70,000 ft. in 55 seconds at Mach 2.

The missile, Beech Aircraft's *XKD-2B-1* uses the 685-lb.-thrust dual-chamber engine, weighing only 17 lbs., in any one of 32 mission profiles to give supersonic high-altitude jet interceptors a run for their money. The engine is now undergoing flight tests and preliminary flight rating tests. The first of its two configurations is expected to be operational in a little over a year.

Using storable fuels, Hydyne and IRFNA, the engine is designed with extreme simplicity, uses explosively formed parts, and has a ceramic liner which reduces heat problems and permits operation over wide thrust ranges. Ignition is hypergolic.

The basic unit is designated P-4, the longer version P4-1. Both produce the same amount of thrust. The P4-1 has a dial system for thrust selection, and dry-start propellant lines. Both engines produce maximum thrust for five minutes, and minimum thrust for eight and one-half minutes.

Beech's 560-lb.-gross-weight *XKD-2B-1* target was developed under a joint Navy/USAF contract, and will become operational with the Navy for both aircraft and shipboard-missile training.

• **Performance** — The Rocketdyne engine powers the vehicle from 500 to 70,000 ft. at speeds from Mach 1.2 to Mach 2. Longest endurance is at Mach 1.5 and 70,000 ft., when the target is fully powered for eight minutes. At 5000 ft. and Mach 1.2, the vehicle is good for 75 seconds. Performance for both versions of the engine is practically identical.

The basic P-4 engine is 18.5 in. long; the P4-1 is 21 in. long. Both weigh 5 lbs. and are 9 in. high. The dry weights are 16.7 for the P-4 and 22.0 lbs. for the P4-1.

Thrust levels for the booster chamber are from 220 to 685 lbs. at a specific impulse of 231 sec., nominally at 35,000 ft. Sustainer thrust level at 262 sec. specific impulse and 70,000 ft. is from 85 to 130 lbs.

Gaseous nitrogen is used for pressurization in both configurations of the engine, and start/stop capability is available at any altitude from zero to 100,000 ft.

• **Controls** — Thrust control and mixture-ratio control is governed by a thrust selection dial system on the P4-1, while the P-4 uses fixed orifices. Sustainer thrust chamber pressure is nominally 303 psia and booster chamber pressure is nominally 200 psia.

Thrust level on the P4-1 is controlled by an orifice selector valve which provides four thrust combinations for

each chamber, with one of the sustainer thrust combinations being blank to provide zero thrust in case the mission requires no sustainer operation.

Sixteen thrust combinations are possible with each of two tank pressure settings, and a field adjustment can increase this to 32 combinations if desired.

The valve has two orifice cylinders for propellants, one metering sustainer flow and the other booster flow. Each has a lower series of orifices to control oxidizer flow and another, upper series to control fuel flow. Selection of propellant flow is made by choosing combinations of these orifices; since both sets of orifices are on the same cylinder, it is impossible to get the wrong mixture ratio.

Intermixing of propellant within this valve is prevented by a series of three O-ring seals on the cylinder between the upper and lower half. In addition, vent holes are located in the valve body between each of the three O-rings to allow escape of any leaking fluid before it gets to its hypergolic mate.

Booster cutoff is accomplished in this same valve by a single pressure cartridge which shuts off both fuel and oxidizer flow to the booster thrust chamber. This cartridge pushes the detent release plunger forward, releasing the spring-loaded poppets which stop propellant flow.

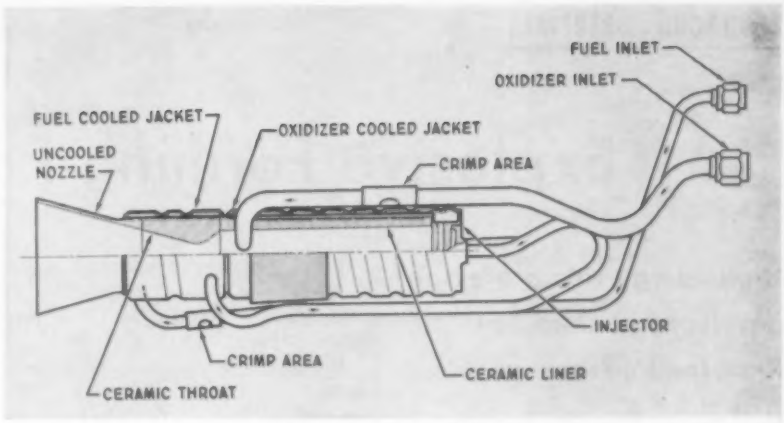
• **Fabrication**—Part of the economy in P-4 and P4-1 is in the fabrication of components. Explosive forming is used to produce the stainless-steel thrust chambers, making a highly reproducible and high-volume item with consistent quality control.

Another aspect is the reduction of components, as evidenced by the calibration technique used. To get the required Delta-P, a technician places a tool on the lines and gradually crimps a section until a flowmeter reads the desired level. The unit is then permanently calibrated. If over-crimping occurs, pressure is put into the line to remove the crimp.

The regeneratively-cooled chambers use a stainless-steel wall construction, a Hastelloy uncooled extension, a refrasil liner and a ceramic throat in the exhaust cone. The outer wall of the thrust chamber is explosively formed, then the liner is placed inside. The outer wall is designed to provide a spiralling coolant passage for the oxidizer.

The uncooled nozzle extension permits changing of altitude optimums for best performance. The oxidizer flows from the aft end of the chamber wall and enters the injector after cooling the chamber. Fuel enters the forward end of the unit and flows directly into the injector.

The aforementioned crimping area makes the chambers interchangeable with respect to pressure drop across the coolant jacket and the injector.



Sustainer Chamber

In the sustainer chamber, a ceramic liner is used instead of the refrasil, and both fuel and oxidizer are used for cooling. The ceramic liner provides a lower heat flux than the resin-type used on the booster.

The nozzle extension used with the sustainer has a greater expansion ratio —24 to 1—than the booster, which has a 6.4-to-1 design; thus the sustainer performs better at high altitudes.

The throat section of the sustainer is cooled with fuel, while the combustion chamber uses oxidizer. A double-weld joint between the two coolant jackets prevents fluids from leaking from one section to the other.

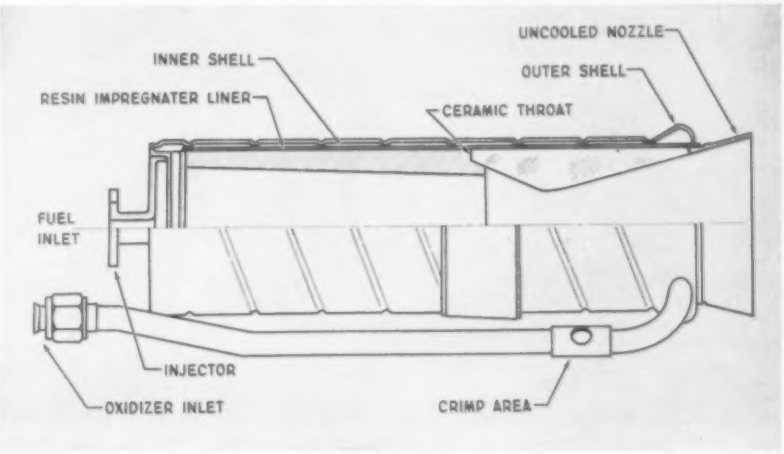
There is no shutoff provision on the sustainer, since the unit is designed to operate until fuel and oxidizer are exhausted. However, for some missions, the booster can be operated alone on all available propellant by selecting a blank setting on the orifice selector valve to prevent propellant from reaching the sustainer.

At present, the fueled engines have a two-year storage time rating, but the goal is five years. Propellants are sealed in the tanks, out of contact with any sealing materials. When the engines are to be used, a squib shears off the tank caps to permit passage of fluid into the previously dry lines.

At the electrical start signal, a pressure-cartridge-actuated burst disc in the pressurizing valve admits gaseous nitrogen to the propellant tanks through check valves and burst diaphragms. Then the two normally-closed propellant valves are similarly actuated, allowing fluids to flow to both chambers where they ignite hypergolically for the boost phase. The booster chamber is cut off at a pre-determined point.

In the start sequence, a slight delay is built into the system to allow cooling oxidizer to flow into the chamber passages before fuel enters the injector. In this fashion, both fluids enter the injector simultaneously, even though the oxidizer has a longer flow path to follow.

Development of the engine began in July, 1959, for the P-4 and in October, 1960, for the P4-1. First deliveries of both types have already been made. ✖



Booster Chamber

Explosive Forming Procedure Nears

High energy rate process in development since Jan. '60. Ryan forming massive rocket fuel chamber bulkheads

EXPLOSIVE FORMING techniques being developed at Martin Co., Baltimore, are expected to reach production capabilities within a year.

Research engineers have been working on the process since January, 1960. The method frees fabricators from the size restrictions of existing presses.

Scale model torus tanks are currently being formed explosively, considerably reducing the weldage and piece work involved in conventional fabrication.

Normal torus tank construction means welding 40 separate pieces to form the finished product. Scale explosive forming experiments use 12 pieces and cut welding footage by 40%. The tank was made in two sections. Five pieces were welded into a cake-pan preform.

The preform was placed in a die, filled with water including a suspended explosive charge. A large holding ring, clamped over the outer edge, assured the necessary seal for drawing a vacuum in the die. In this case the charge was circular in shape.

After detonation, the preform resembles a hollow doughnut sliced sidewise.

• **Exotic fabrication** — Explosive forming is actually the earliest known method of high energy rate metal forming. It was first used by an Englishman, W. Claude Johnson, in 1897. Since 1957, a very large segment of the missile/space industry has moved into the field.

CAKE-PAN PREFORM for scale torus tank is welded from twelve sections for explosive forming rather than the forty sections in conventional fabrication.

Production Stage at Martin

The method is only one of many forms of high and medium energy rate processes being developed in the U.S. but it spawned most of the others. The largest obstacle is that the explosives are involved and almost every municipality has well defined and prohibitive laws governing the use of such materials. While these were originally directed against firearms and then heavy construction, a limiting condition existed before industrial use of explosives for fabricating evolved to its current state.

Much remains to be learned about the process. But the swift movement of the missile/space industry into tougher and tougher materials, outstripping the capabilities of the most advanced metal working techniques is again placing prime emphasis on effect and leaving the cause, or understanding, running a poor second. In this case, the effects are practically finished products.

High energy forming is basically the same as the more familiar, conventional forming methods. Force and time are still the dominant characteristics. The real problem is in the nature of the workpiece and what happens during the process. This is the area being intensely investigated by government, industrial and academic researchers.

• **Huge parts**—In application, explosive forming is moving into the massive product area. Ryan Aeronautical Co. is currently working on a gore 15 ft. in length and 8 ft. wide at the broadest end.

The gore is one section of a huge elliptical dome which could be part of a large rocket fuel tank. The gore die is a concrete fiberglass-faced tool weighing over 40 tons. The gore itself will be fashioned from 5086 aluminum alloy, representing the biggest explosive forming job at Ryan to date.

In spite of the rapidity of high energy rate forming, the metal itself moves relatively slowly—around 100 to 200 fps, a velocity below the critical impact velocity of most metals.

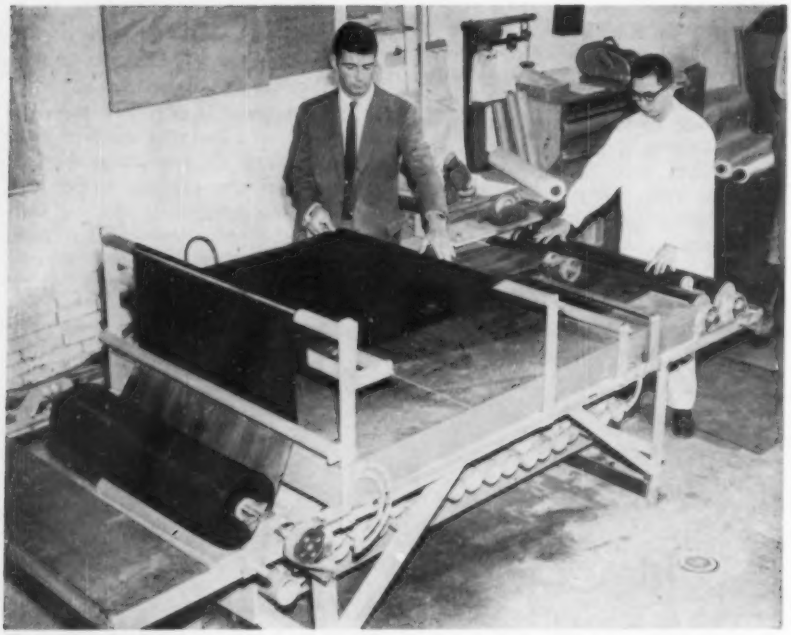
The explosive is separated from the workpiece by a coupling medium such as water. This fluid has the effect of rounding off the pressure pulse generated by the detonation, which in turn prolongs the pressure-work time over the metal to be formed. Charge distance is known to be extremely critical. ¤

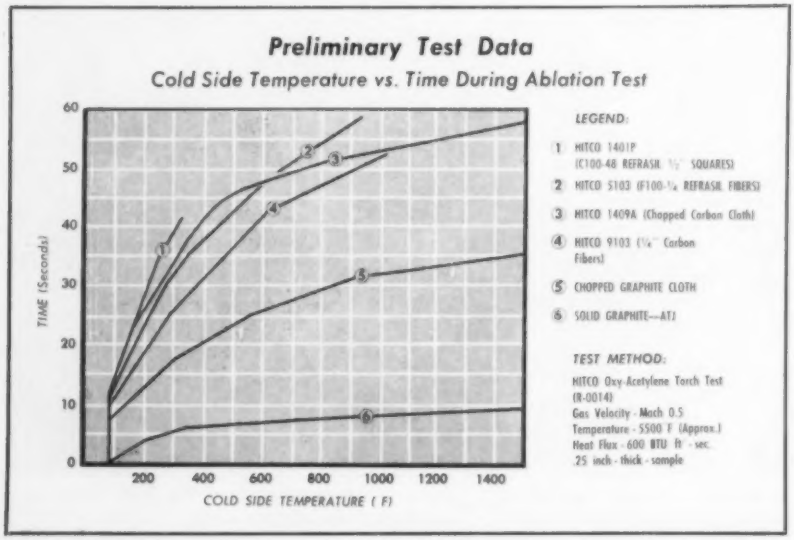
CIRCULAR SHAPED charge forces the preform against the die in the Martin tank.

FINISHED TORUS configuration illustrates the capabilities of the high energy rate forming method. Martin did not reveal ultimate use of such tanks.

Off the Loom: Rocket Ablative Material

High temperature fabric by Thompson Fiber Glass reported to possess far better thermal properties than graphite





LOS ANGELES.—Erosion-resistant ablative materials for high-temperature rocket engines have been developed by H. I. Thompson Fiber Glass Co.

The carbonaceous materials, designated HITCO-C, have a purity of 98% carbon and are being fabricated in both fiber and fabric form.

The company says the materials retain strength over a broad temperature range, and even show a strength increase at temperatures over 3000°F. Compatible with most resin systems, the HITCO-C series can be fabricated by standard reinforced plastic techniques such as high-pressure molding and tape winding.

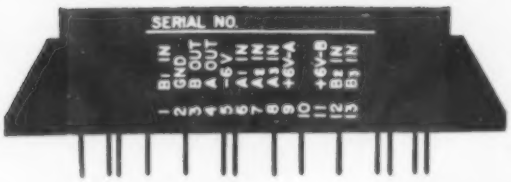
J. Pat Sterry, Manager of the Materials Research Division for H. I. Thompson, said the materials have the high-temperature erosion-resistance characteristics of graphite materials, but their thermal conductivity is orders of magnitudes lower.

"There are other carbonaceous materials on the market," Sterry said, "but they evolve large quantities of gases and will shrink and lose over half their strength before they reach 1500°F. Some of them also lose their identity when used with resins, and therefore don't serve any reinforcing function."

• **High properties**—He said the HITCO-C series currently consists of the fiber and cloth materials, both of which are now in production. The satin-weave cloth is being produced in rolls 32 in. wide and 50-75 yds. long. Its warp break strength is 25 lb./in. or greater, and weight per linear yard is about 7.5 oz.

Using molded parts of 50% fiber and 50% phenolic resin (by weights), the company found that the mechanical properties of the fibers were quite high. Tensile strength is about 8500 psi, flexural strength is 15,000 psi, compressive strength about 19,000 psi and flexural modulus 1.9 x 10^6 psi. Sterry expects that the fabric laminate properties now being measured will prove to have higher values than the fiber-resin.

(Continued on page 50)



In less time than it takes light to cross this room, a new product, **DELCO'S NEW** high speed **10 MC** silicon modules, could: (1) correct the course of a missile in flight; (2) make it possible for sonar pickups to track and compute the position of targets with microsecond accuracy; and (3) handle any number of other airborne guidance and control functions that previous modules—due to low speed or environmental or performance limitations—could not handle. Delco Radio's 10mc modules, with a maximum gate-switch speed of 40 nanoseconds, convert data 100 times faster—even under the most extreme environmental conditions.

These **SILICON** modules come epoxy encapsulated, and operate over a temperature range of −55°C to +100°C. And these same reliable **DIGITAL** circuits are available packaged on plug-in circuit cards. These Delco **MODULES** are environmentally proved to: **SHOCK**, 1,000G's in all planes. **VIBRATION**, 15G's at 10 to 2,000 cps. **HUMIDITY**, 95% at max. temp. **STORAGE AND STERILIZATION TEMP.** −65°C to +125°C. **ACCELERATION**, 20G's. Designed for systems using from one module to 100,000, and the module's rated performance considers the problems of interconnection. Data sheets are available. Just write or call our Military Sales Department.

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TYPICAL MULTI-CHANNEL MEMORY UNIT *

MARQUARDT MULTI-CHANNEL MEMORY SYSTEM

allows realistic simulation of longer range and lower altitude tactical training missions

Based on a major technical breakthrough in information storage, Marquardt's new bombardier/navigator radar trainer system provides outstanding simulation characteristics. The flexibility and capacity of the Multi-Channel Memory—a high density storage medium—make possible realistic simulation systems capable of meeting the advancing speed, range, and altitude requirements of aero-space technology.

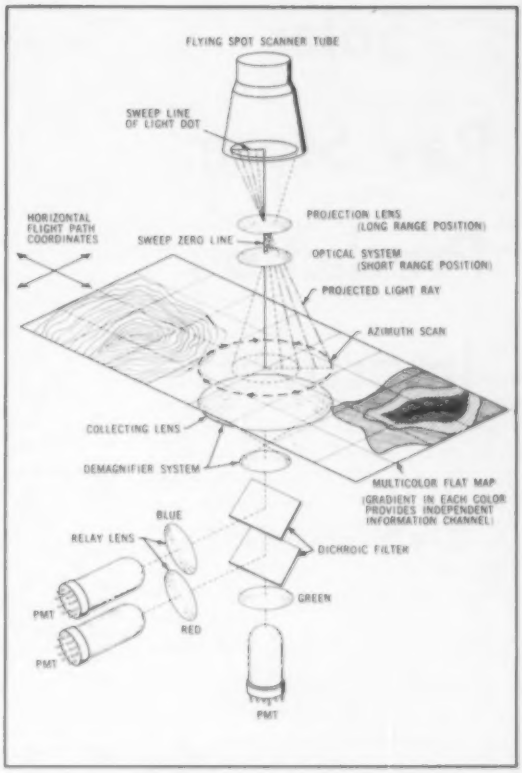
The Multi-Channel Memory uses a three color film transparency in which terrain information and radar reflectivity data are stored on a map scale ratio of three million to one, or better. A highly detailed terrain map representing a land mass area 2,000 miles by 3,000 miles can be permanently stored on a slide only 48 inches by 72 inches. Because the map transparency is flat and terrain elevations are reproduced electro-optically, there are no physical limitations to its use. The system is particularly well suited for very low altitude simulation.

Information in the Multi-Channel Memory System is coded as varying densities of the three colors of the film transparency. During operation the transparent map is scanned by a flying spot scanner. After passing through the film the light is separated into various channels by filters and mirrors and converted to electronic signals by photomultiplier tubes. The light intensity in each channel is dependent upon the absorption of the corresponding color dye in the film. The signals are then processed by a high speed computer and displayed on the face of the PPI (plan-position-indicator) radar display.

Because of its flexibility and large storage capacity, the Multi-Channel Memory System has application to missile and space training problems, information storage and retrieval, automatic language translation, advanced command and control systems, and similar computer uses.

The bombardier/navigator training system mentioned above, and now being developed for the Air Force, is the result of more than ten years of experience in the development and manufacture of trainers and simulators. Marquardt has successfully produced, installed and maintained world-wide—on time and at low cost—bombing and navigation trainers, gunnery radar trainers, AEW/CIC trainers, special purpose trainers, and ground control intercept trainers. For information concerning Marquardt's training and simulation systems capabilities, contact William Lord, Pomona Division, The Marquardt Corporation, Pomona, California.

Scientists and engineers experienced in the fields of simulation and training systems are invited to investigate exceptional career opportunities with The Marquardt Corporation. All qualified applicants will receive consideration regardless of race, creed, color, or national origin.



DATA EXTRACTION FROM COLOR TRANSPARENCY
The principle of land mass simulation storage and readout is shown above. Terrain elevation and radar reflectivity are coded as varying densities of the three colors of a color film transparency. As the light source simulates airborne radar scan, signals are generated by the photomultipliers to provide information necessary to simulate a radar presentation.

★ MULTI-CHANNEL MEMORY UNIT
Shown on the opposite page is the heart of the Multi-Channel Memory System — a three color film transparency. Each color provides a permanent and separate information channel in perfect register at any point no matter how large the map.

THE Marquardt CORPORATION

CORPORATE OFFICES, VAN NUYS, CALIFORNIA

ASTRO ◆ OGDEN DIVISION
◆ POMONA DIVISION
◆ POWER SYSTEMS DIVISION

Solar Ray Storm Prediction Improved

by William Beller

A SCIENTIST at the University of California has devised a way to predict with reasonable accuracy the onset of solar cosmic-ray emissions.

He also has a fairly reliable method for making long-range estimates of the maximum number of sunspots that will occur at the peak of the next sunspot cycle.

Such information is vital for the safety of prospective space travelers, and is also of high engineering value to space-capsule designers.

The man who derived the methods is Dr. Kinsey A. Anderson, U. of C. assistant professor of physics.

• **No tarrying in space**—The danger of solar beams to astronauts was first recognized when a flare on May 12, 1959, sent protons of extremely high intensity throughout the solar system. Then—as though to drive the warning home—three very intense solar beams occurred two months later.

On the basis of the Anderson methods, it appears that four-day trips are the longest that can be made with fair assurance that no solar cosmic rays will be met. For longer trips, particularly at times of high sun-spot number, shielding is definitely needed.

Solar cosmic-ray particles, which are almost entirely protons, are the only sources of large and dangerous radiations coming from the sun. During the great July, 1959, solar proton event, the total radiation dosage might have reached 200 rem, even with radiation shielding of 8 gm/cm². The permissible once-in-lifetime dosage for workers in a radiation environment is regarded by many authorities as 25 rem.

Solar x-rays and electrons, including those in storm-producing gas clouds, are said to be too low in energy to have substantial penetrating power. And even solar gamma rays, though quite penetrating, occur only in very short bursts and infrequently.

• **Radio engineers used it first**—The development of a sunspot or a group of sunspots from mere specks to the maximum number of spots may take about a week. Several more weeks may pass before the last spot decays completely away. Anderson claims that the large flares that produce proton flux occur mainly in sunspot groups having lifetimes of at least one week, and particularly in those that reach a fair degree of complexity.

Anderson divides the "solar beam" prediction problem into deriving (1) a relatively long-range prediction of what the solar activity will be during the next sunspot maximum (in 1968); and (2) the day-by-day probability of avoiding a solar beam.

For predicting the peak sunspot number about three years ahead of the solar maximum, he suggests a technique radio engineers use to forecast radio propagation conditions. This is based on the data in Figure 1, where the early development of the last four sunspot cycles is shown.

The sunspot minimums are all started at t=O. Anderson observes that about 1½ years past minimum, the two cycles that will eventually attain high sunspot numbers lie distinctly above the curves that attain much lower numbers. Therefore, he concludes that the smoothed sunspot data available in late 1965 should indicate whether the peak of Cycle 20 will be extremely high or will fall substantially below the monthly average of 200 sunspots per day attained in early 1958.

The maximum sunspot number appears to be loosely connected with the number and severity of solar proton events. Therefore, even if the next cycle should be less active than the present one, there may not be complete assurance that the number of solar proton events will diminish.

• **Short-term forecasts**—The key to making short-term predictions of solar proton events lies in examining the penumbral areas of active sunspot groups. (The penumbra is the shaded area surrounding the dark portions in a sunspot.) The method of analysis:

1) The size of the penumbral area in the sunspot group of July, 1958, (Figure 3) is measured two days before the large flare of July 7. The area may be taken to be the sum of the areas of the two largest penumbral regions. The penumbral area then was

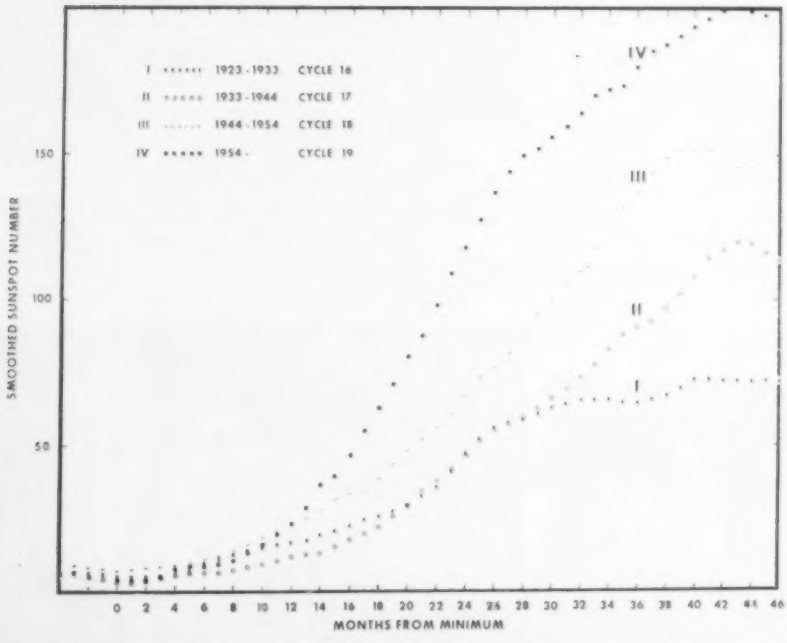


Figure 1. *At about 18 months past solar minimum the curves of smoothed sunspot numbers give a good indication of how peak sunspot numbers will be for each cycle.*

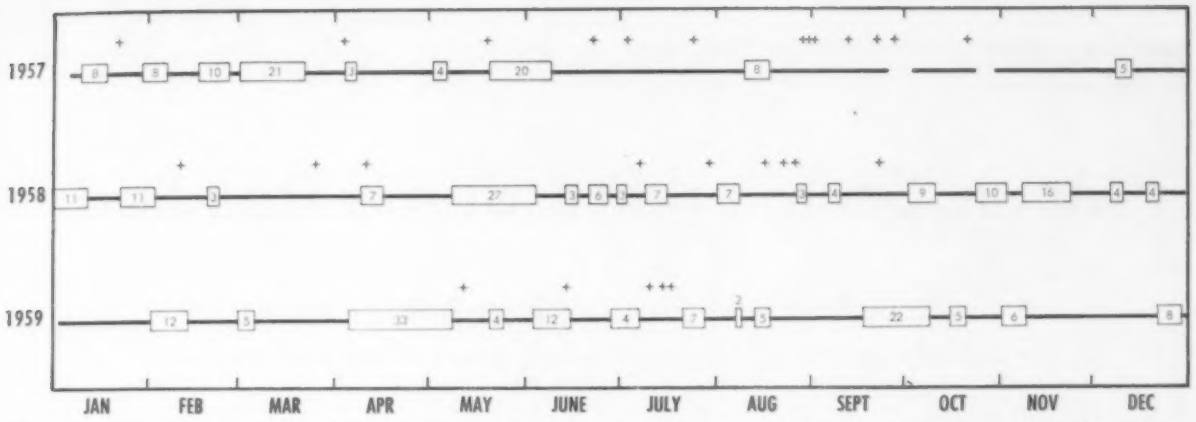


Figure 2. *The solid lines denote times when large penumbral areas were present in one or more sunspot groups. The line continues until the sunspot group goes behind the west limb even though the penumbra may have vanished before this time. The open boxes are times when only small and dissociated grey patches were present. The number in the boxes gives the time in days that this situation lasted. The crosses indicate the first arrival of solar protons at the earth.*

smaller than those in the other two sunspot groups associated with very great proton intensities at the earth during May, 1959, and July, 1959.

2) The daily sunspot records of the Athens Observatory from Jan. 1, 1957 to June 30, 1960, are next examined. Whenever the total penumbral area confined to one or two patches in a sunspot group exceeds that of the July 5, 1958 criterion size, a solid line is drawn on an axis marked off for the 365 days in a year.

The line is continued until the sunspot group leaves the visible disc, even though the penumbral areas may have completely disappeared before this time.

If, when this group disappears, the penumbral area in other sunspot groups present on the visible disc do not exceed the July 5, 1958, criterion size, an open line or box is drawn along the time axis. This is continued until a group of spots having a penumbral area greater than the criterion size appears again. The result of this analysis for the 3½-year period is shown in Figure 2.

3) The beginning of each solar proton event is then marked by a star on this plot.

A further discussion of this method is in "Preliminary Study of Prediction Aspects of Solar Cosmic Ray Events," NASA Technical Note D-700.

On the basis of Figure 2, several conclusions can be reached:

—Solar proton events occur predominantly on the solid lines.

—On two occasions, the solar proton emission began above an open line.

—In several instances, the solar proton even began very near the end of a solid line. This is described as due mostly to flares in sunspot groups just disappearing from the visible disc, in which the once large penumbra had nearly vanished.

—Since the boxes take up one-third of the total time on the diagram, it would be expected on a random-chance basis that about 13 out of the 40 solar-proton events would fall into the boxes. However, only two do.

• **Best times to travel**—Four-day excursions into space should be started when an open box appears—unless a proton event is occurring; then the trip should be delayed four days. If the box is still open when the trip is over, another should be begun at once. Even if the excursion time runs out of the box, it should be completed. (Results of such programing is shown in table.)

Through this technique, 117 round trips could have been made over a 3½-year period with only two solar-beam encounters. This is far better than random chance would have given.

When the trip is extended to seven days, chance of running out of a box and onto the line becomes more probable. Out of 77 trips, five would have met with proton flux during the 3½-year period. As the trip is extended, chance of avoiding a proton flux rapidly worsens. ⌗

Analysis of the Solar Beam Encounters of Hypothetical Space Flights Allowed by the Penumbral Development Criterion in Recent Years

Year	No. of 4-Day Round Trips Possible	No. of Solar Beam Encounters	Max. Riometer Effect for Beams Encountered	No. of 7-Day Round Trips Possible	No. of Solar Beam Encounters	Max. Riometer Effect for Beams Encountered
1957	21	0	—	16	1***	Not reported but small
1958	37	1*	3 to 4.5 db	25	1	3 to 4.5 db
1959	38	1*	1.5 db	23	2†	1.5 db >15 db (First Great July event)
1960**	21	0	—	13	1‡	Not reported, but intermediate intensity; two separate events encountered
TOTAL	117	2		77	5	
Total No. of Days Average	468			539		
Percent of Time Used, 1957-1960½	36			46		

* *These encounters unaviodable by present criterion.*

** *Up to July 1 only.*

*** *Penumbra greater than criterion size appears one day after excursion begins. Protons arrive at earth 5 days after this.*

† *Penumbra greater than criterion size appears 2 days after excursion begins. Protons arrive at earth 2 days after this.*

‡ *Penumbra greater than criterion size appears one day after excursion begins. Protons arrive at earth 3 days after this.*

Moon 'Sampler' Prototype Readied

JPL studying small chromatograph built by Aerojet for inclusion in Surveyor payload; would prove absence of moon life

AZUSA, CALIF.—Aerojet-General has delivered the prototype of a lunar gas chromatograph (LGC) system for the *Surveyor* vehicle to Jet Propulsion Laboratory. Evaluation studies of the device are getting under way.

The "moon sampler" is designed to provide information on the composition of non-mineral materials in lunar surface samples, raised to the instrument from depths up to several feet by the *Surveyor* drill.

The LGC is highly specialized in scope as compared to a similar moon soil analyzer to be used in the *Prospector* vehicle payload. But its application —to determine if terrestrial-type life exists or has existed on the moon—is no less important. The results could lead to more positive conclusions to the theory that microorganisms exist in space.

In initial payload design, the LGC was alloted absolute maximums of 15 lbs. and 100 cu. in. in weight and volume. Ten watts of power was all that could be spared. The operational package had to contain all electronics required to process the low voltage supply, operate detectors, and provide outputs of derived information compatible with the telemetry system. In addition, the package had to self-program itself through all operations after receiving a single ON pulse.

During launch and initial climb, the instrument would have to withstand the vibration and acceleration of the landing-vehicle rockets, and 100-g deceleration loads at launching. The predicted 300° centigrade temperature variation on the lunar surface made high component density of electronic circuitry seem practically impossible.

• **Design features**—The Aerojet design wound up as a 12-lb., 675-cu.-in. package—well within the required specifications. Electrical power, found to be insufficient at the original 10 watts, has been boosted to 100 watts by modifications to the *Surveyor* electrical system. The revision now provides enough power to operate the furnace for periods needed at 150°, 325° and 500°C control temperatures.

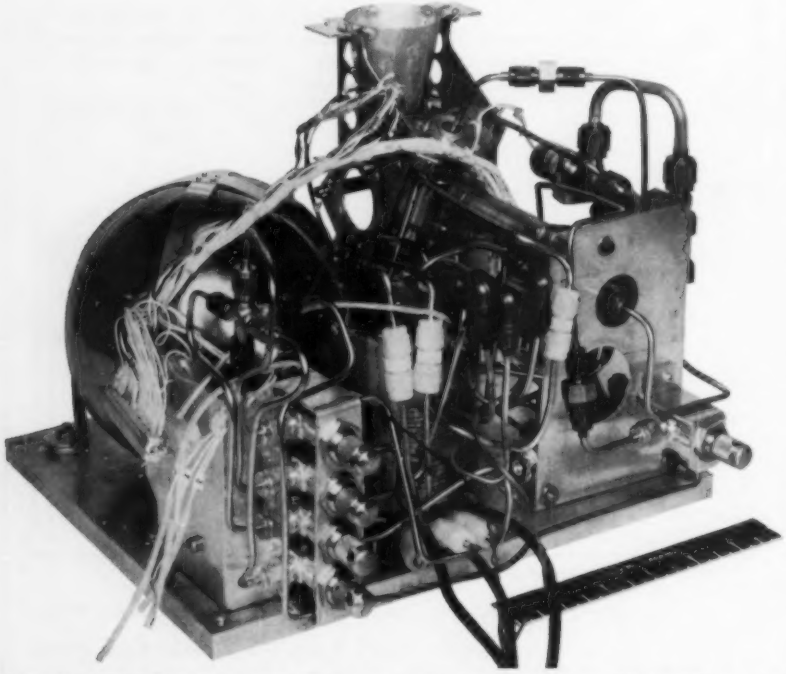
The volumetric sampler, actuated by an 85-cu.-ft. helium supply in a titanium sphere drops 4 cc of rock particles into the furnace as many times as the gas supply allows. The soil is then heated electrically to one of the three control temperatures to volatilize compounds of low molecular weight and pyrolyze heavier ones.

In the present design, there is sufficient carrier gas for a minimum of 12 samplings plus one calibration test. An original requirement for pulverizing the samples was omitted from the present configuration after it was shown that the drill produced particles fine enough for direct feed to the furnace.

A reduction in the size of valve components in the LGC is another major contribution to design and operation of the complex flow system. Carrier-gas shut-off is handled by a 0.26-lb. double-latching solenoid valve requiring only a brief pulse. Another 0.16-lb. solenoid-actuated valve is used in the analytical valve system. In response to an ON pulse from the programer, the valve operates a piston-cylinder device attached to a ratchet with 30° steps.

Three specially contoured cams are attached to the ratchet through a central shaft. In function, the valve, ratchet and cam assembly operate as four three-position spool valves. System valving setups change with each 30° step—with 12 configurations available during the period of each full analysis.

The programer activates a pneumatic stepper through semiconductor counting and magnetic frequency-dividing circuits. Resistors in the R-C oscillator at each of the 12 steps vary the count rate.



LUNAR CHROMATOGRAPH designed by Aerojet-General is a 12-lb., 675 cu. in. package. With present design, 12 samplings plus one calibration test can be run.

• **Three columns**—To obtain the maximum information from each soil sample, the design uses a three-parallel analytical column system—two columns for partition, the other for adsorption. Anticipating polar compounds in the products of the analysis, one column material is 20,000 molecular-weight polyethylene glycol on Teflon. A second column uses a mixture of neopentyl glycol sebacate and Apiezon L on Chromosorb W; the third column 5A Molecular Sieve. Programed backflushing occurs after a 30-min. analysis period.

The soil samples pass through a thermistor thermal conductivity cell prior to splitting and entering the columns, in order to obtain an approximation of the gaseous sample size. A cross-section ionization cell with a radioactive source of titanium tritide is located at each column exit. These detector types offer large dynamic-sample size range and are relatively insensitive to flow rate and temperature, but other detector types are still under study.

In conjunction with the detectors, electronic systems are typical high-component-density type, and are also used with the spacecraft's 0-5-volt telemetry system. The design incorporates automatic range switching for a three-decade readout.

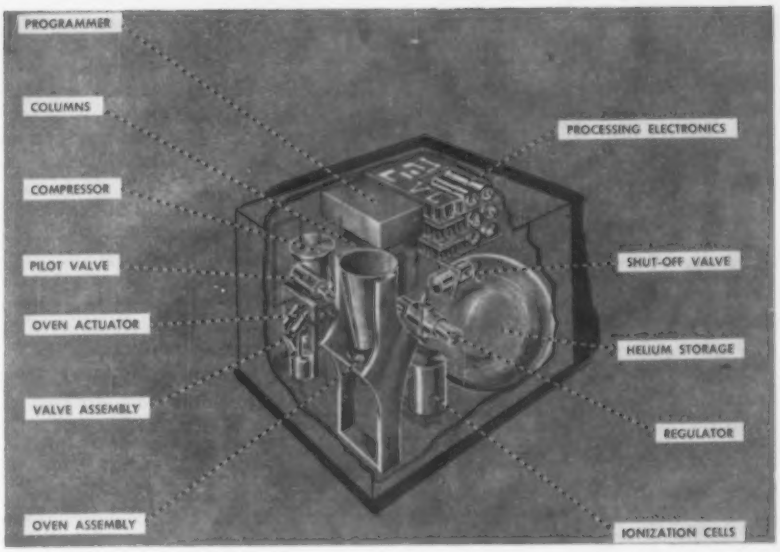
• **'No' answers only**—There is no plan to analyze the lunar atmosphere with the LGC. Since the total pressure of lunar surface gas is theorized to be about 10^{-14} earth atmosphere, Wilson says, other instrumentation is better suited for this analysis. Prime feature of the LGC is its ability to detect, in gas from heated soils, a large number of components from among a wide variety of compound classes.

Verification of theories on moon geology by earth experimentation is unfortunately impossible. The fact that the lunar atmosphere and hydrosphere was lost at a relatively early date, coupled with the belief a protective meteorite layer covers the moon, gives the "on-site" LGC investigations great scientific importance.

The Aerojet LGC design is based on the premise that organic compounds exist within the moon structure. One theory, for example, postulates that 5 to 10 grams of such compounds have been deposited on each square centimeter of the moon and localized within some tens of meters below the surface.

Studies and experiments started in late 1960 indicated that a high degree of scientific information would be obtained—and the presence of characteristic compounds such as acetone and acetonitrile would be detected—if biogenetically derived compounds are present in the lunar soil.

Scientists at both Aerojet and JPL claim that the moon sampler can prove the *absence* of terrestrial forms of life in each sample analyzed. Lack of acetone and acetonitrile after pyrolysis of lunar dust would indicate no alanine was present—hence no evidence of earth-type life. Opposite results lead to the situation where no definite conclusions about "moon-life" can be made. The experiment provides only a positive NO answer for the particular sample being analyzed. ⌗



VEHICLE WAS DESIGNED using premise that there are organic compounds in the moon. Payload, now undergoing tests at JPL, will be included in Surveyor Vehicle.

A New Tool in Space

Gas chromatography is the nearest thing to a universal analyzer yet developed. This is true at least where vaporizable materials are involved. Gas chromatography is a physical separation method in which a solute is distributed between a stationary sorbent phase of large surface area and a mobile gas phase. The mixture of carrier gas and sample flows into a partition column, containing a substance, such as a high boiling liquid in which the materials in the sample have different partition coefficients.

They are retained in the column for different periods of time and travel through it at different speeds. Entering a detector at the end of the column, they register a series of signals resulting from concentration changes and rates of elution.

If a recorder is tied to the detectors, the signals appear on a chart as a chromatogram—a series of characteristic peaks. The appearance time, width and height of these peaks can be measured to give analytical data on the sample composition.

Senate Committee Relaxes Defense Ad Restrictions

THE SENATE Appropriations Committee has opened the door for extensive modification of the House amendment to the fiscal 1962 defense bill which would have eliminated the cost of defense advertising as an allowable contract cost.

An amendment requested by the Dept. of Defense exempting from the restriction advertising costs connected with recruitment for contractor personnel, procurement of scarce materials and disposal of scrap was accepted by the Senate committee. The committee also went a step further to meet industry objections to the severity of the bill by recommending as legitimate contract costs advertisements for the procurement of subcontractors required for the performance of the contract.

The Senate committee said it believed that certain types of advertising by defense contractors in the performance of defense contracts should be considered as an allowable item of cost. It concurred, however, with the expressed desire of the House to end such abuses as including unwarranted advertising as part of the cost of performing defense contracts.

The committee amendment also directs the Secretary of Defense to bar any advertising "which is designed to pirate personnel from one defense contractor by another defense contractor." The two versions next must be reconciled in a joint House-Senate conference. ⌗

'Interconnection' Clears W&C Snarl

by William Gilmour

ON MARCH 27 of this year, MISSILES AND ROCKETS *published a Special Report outlining in detail the "Snarls in Missile & Cable Industry." Among the deficiencies highlighted in this report were the lack of clearcut, definitive standards, poor intra-industry cooperation and the absence of design concurrency between prime contractors and the cable and connector industry.*

The report went on to point out the need for firm standards and "standardization" within the Defense Department. And, although the survey pointed out that much had been accomplished, it made it clear that "all involved in the missile wire and cable business are agreed that more lead time and design concurrence are essential. So long as the cabling is left until last, poor design and problems will naturally result."

The following article shows how one company worked with the military and a special group of "interconnection" engineers to lick the problem of design concurrence.

William Gilmour, the author, is presently a radar project engineer, Wayland Laboratory, Raytheon Co.

ONE OF THE MOST pressing needs in the missile industry is for prime contractors to realize that engineers must be provided to work with cable and connector manufacturers in the initial design stages of a missile system.

As MISSILES AND ROCKETS pointed out in its special report on "Snarls in Missile Wire & Cable Industry" (M/R, Mar. 27, p. 20), contractors seldom include cable and connector specialists until the system design has been already fixed. By this time, it is too late.

This problem was encountered by Raytheon several years ago and was solved only through the use of "interconnection" engineers. These men were responsible for the design and development of inter-unit connections and the choice of the proper interconnecting cable assemblies to meet the system specifications.

The story of the success of this approach graphically illustrates the necessity for early integration of cable and connector specialists in the design and development phases of a weapons system.

When the engineering model of a mobile integrated missile system was first designed about five years ago, the network of interconnecting cable assemblies was selected *after* component hardware of individual units had been designed and partially fabricated.

This led to a tentative choice of cable assemblies using cables and connectors available to meet MIL-C-13777 and MIL-C-5015. However, these were large in number, bulky and far more expensive in both initial cost and logistic complexity than seemed warranted.

The figure shown on pg. 36 gives a graphic example of the system before a team of interconnection engineers examined the problem. Many of the cable runs are broken into three assemblies to meet the performance required by MIL-C-13777—specifically, that the maximum footage on a reel was limited to one-third of the cable weight and size.

At this point, the Army Rocket and Guided Missile Agency (ARGMA) requested that a detailed study be made of the fabrication and logistic problems of storing, sorting, laying and correctly connecting the 69 cable assemblies, as well as the number of men and vehicles necessary to accomplish this under tactical conditions, and the adequacy and reliability of these assemblies.

• **Study approach**—The initial design of these units was such that practically every unit had a cable "entrance area." And, since these areas would be the only part of the individual units that would have to be redesigned, the interconnection engineers would have almost a free hand in solving the problem.

In addition to the twist, bend and impact tests of the cable required by MIL-C-13777, the following tests were devised jointly by Raytheon and a special Frankford Arsenal evaluation group:

—Coaxial cables were tested under loads simulating actual usage.

—Cable assemblies were tested for feasibility of connecting and disconnecting at low temperatures under simulated field conditions, as well as being tested for a watertight seal between connector and cable.

—Assemblies were reeled and unreeled at low temperatures under field conditions to determine the best field-handling methods and the time required for these operations.

—Cable system identification markings were discussed to determine whether coded numbers, letters or painted stripes should be used.

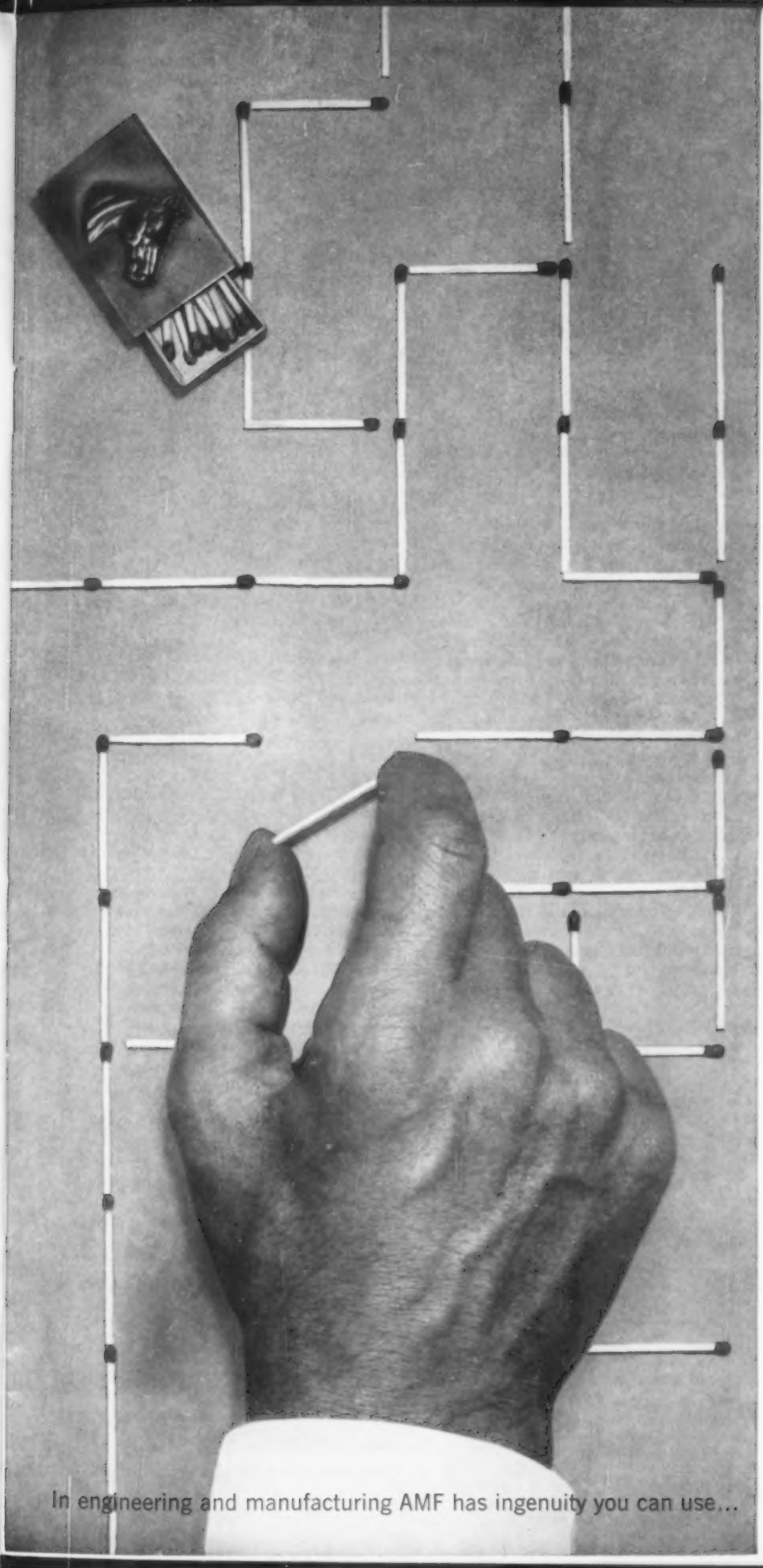
• **Results**—One immediate conclusion of Frankford Arsenal's evaluation was that the cables were designed without due consideration of their diameter and weight.

Using data from many knowledgeable sources—including Frankford Arsenal, Raytheon field engineers, and the cable and connector companies involved—the interconnection engineers analyzed every load of the battery's cable system. Taking into account the voltage, current and shielding necessary for each cable and connector, the interconnection specialists evolved a practical means for improving the cable system.

This improvement took into consideration the customer's desire for both a foolproof cable system and logistic simplicity.

• **New cable philosophy**—As a result of this study, a new cable philosophy was proposed for the system at a Raytheon interdivisional conference:

—All cables between units must be single runs to eliminate the confusing



He designed a new interchange for radio traffic

This AMF engineer, part of an AMF-U.S. Army team, solved the problem of traffic delays and personal danger in manual re-connection of jumpers when interchanging R.F. transmitters and antennas.

His solution is a push-button-operated, coaxial crossbar switching system, using vacuum switches for circuit selection. A typical system consists of 4 transmitter inputs, 7 antenna outputs plus a dummy load, in a 4 x 8 matrix that can be mounted in a 19" rack. It can be controlled locally or remotely over any type of communication network having a bandwidth of at least 200 cycles.

AMF's coaxial crossbar switching system provides 100% flexibility in circuit path selection and accommodates power levels as high as 500,000 watts and frequencies up to 30 megacycles. It allows 100% utilization of all transmitting equipment. Stubs are automatically eliminated.

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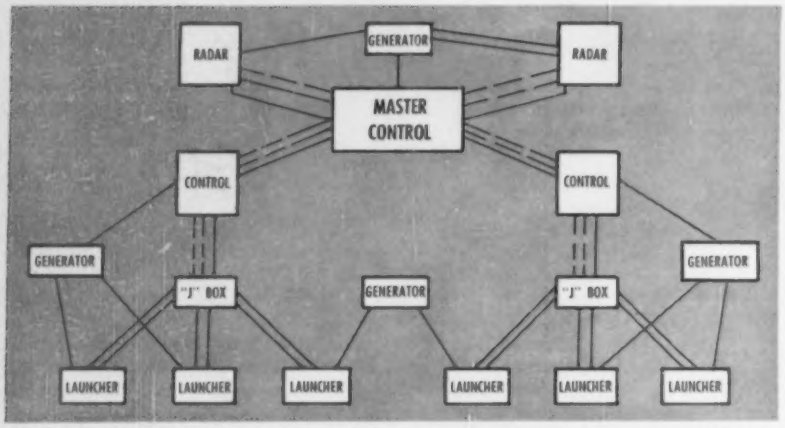


CABLING PROBLEMS of tactical missile systems are graphically portrayed by the diagram above. The complement of cable assemblies per system consisted of 69 cables, 12 different cable types and numerous multi-runs. This was before the problem was examined by Raytheon's Interconnection engineers.

possibility of cross-coupling midpoints of multirun cables. This is contingent on development of a new cable weighing less than 450 lbs. per 1000 ft. and having a diameter of approximately one in.

—A cable design containing the optimum number and type of conductors for this specific application must meet the performance requirements of MIL-C-13777.

—A simple system of electrical polarization is required to enable all data cable assemblies to be identical and to eliminate all route or destination markers.

—Cable assemblies can then be reduced from twelve to two: one for power and one for data.

—The power cable was to be a standard four-conductor cable type, but the diameter and weight was to be minimized.

—The data cable must contain the necessary conductors for control, synchro, video, trigger and even telephone circuitry. The requirement for light weight and minimum size puts this specification beyond the present state of the art of the cable industry.

• **New materials**—These recommendations forced Raytheon Engineers to consider new primary insulation materials not previously approved by Army Ordnance in MIL-C-13777.

These new materials would be necessary to ensure that the diameter of the finished cable would not exceed one inch—the maximum diameter to fit 375 ft. of cable onto the specified Ordnance reel—while the weight of the loaded reel would not exceed 170 lbs.

Although the cable was to contain 34 single, two sets of triple, and two 75 ohm coaxial conductors, the reinforced steel strands in the conductors and the reinforced artic neoprene jacket were still considered necessary for long field life.

After many tests on proposed cable materials, polyethelene—conforming to Specification L-P-590 (Type II-Grade 4 or 5)—was found to equal in many respects the performance of the usual latex or rubber insulation compounds. It proved to be superior to these compounds in cold-temperature handling tests at −65°F. If this material was to be used, however, cable companies had to perfect a low-temperature cure for the outer jacket of Artic Neoprene.

• **Connectors also studied**—Along with the modifications outlined below, a one-piece insert with a positive interfacial sealing action in a heavy-duty, machined, waterproof connector was proposed. Other recommendations were:

—A new insert style with 40 #20 and 2 coaxial contacts to accommodate the new data cable.

—A jamnut receptacle for ease in the unit harness assembly.

—Complete ejection of the plug from the receptacle by the coupling ring.

—No contacts making connection until polarizing bosses and grooves have properly oriented the inserts.

—A modified double-stub thread for quickness of mating and disconnecting, ease of cleaning, prevention of cross-threading and resistance to loosening under vibration.

—A waterproof cable clamp adapter specifically for the cable outer diameter, with a cable-strain relief to eliminate strain on the contact solderwells, and with a left-hand thread to prevent inadvertent wringing of the conductors from the solderwells by field personnel loosening the wrong joint.

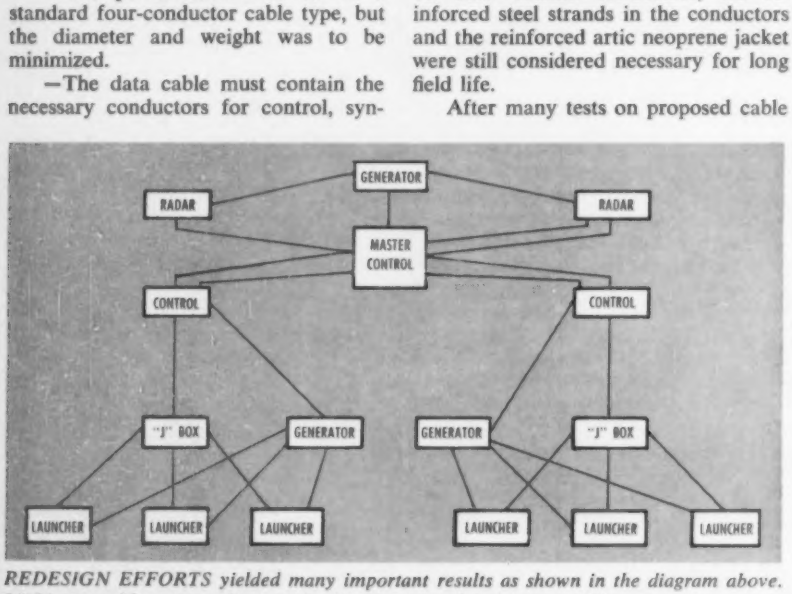
—Caps retained by a wire rope with a breaking force of 100 lbs. to prevent RF interference that exists with caps of the more popular beaded chain.

• **MIL-C-13777 revised**—As this program moved toward completion, a cable conference was held at Frankford Arsenal for representatives of the manufacturers, the military and users. The purpose of this conference was to revise the military specification (MIL-C-13777) to allow the inclusion of the materials that the Raytheon/Frankford tests has proven suitable for cable use.

The changes incorporated into the specification included: permitting materials other than latex or rubber for primary conductor insulation, elimination of the previously required identification groove, tightening of the specification "torture tests" to more adequately simulate field conditions, and specifying definite design requirements for the inclusion of coaxial conductors to meet the same operational requirements as the conductors of the power and data cables.

• **Marked improvement**—As shown

(Continued on page 57)



REDESIGN EFFORTS yielded many important results as shown in the diagram above. Multi-run cables were eliminated; the number of cable assemblies per system was reduced to 29; and the number of different assembly types to two—one for power and the other for data.

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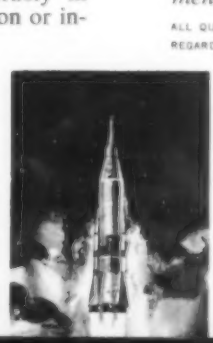

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MA Getting 11-in. Flight LOX Valve

Unit with 6500 gpm capacity flow weighs only 50 lbs. —designed specially for manned orbital flight

THE LARGEST FLYING LOX valve in the world will be aboard the *Atlas* booster that puts the *Mercury* capsule into orbital flight.

The unit, with an 11-in. line diameter, and weighing only 50 lbs., was developed by the Components Dept., Reaction Motors Division, Thiokol Chemical Corp., for the *Mercury Atlas* series.

Before Thiokol delivers the valves, they are pressure-tested, vibrated, cycled, flowed, subjected to extreme environmental conditions and spun on a special horizontal centrifuge at simulated accelerations exceeding 130 g.

In operation, the forward valve section is bolted to the missile sustainer and the aft valve section fastened to the "booster" stage of the *Atlas*. At stage separation, the aft valve section is pulled out of the forward segment, permitting a poppet to be forced shut by spring force and fluid pressure. A by-pass continues to feed LOX to the sustainer engine.

The aft section holds the spring-loaded poppet open while the valve parts are mated. This section also absorbs the stress and misalignment generated during flight.

The forward section, constructed from spun and brazed aluminum, consists of body, ring and poppet assemblies. The body assembly includes integral guide vanes with a centrally located tube which serves as a poppet guide and spring housing.

The ring assembly, bolted to the body assembly with a spirally wound gasket at the joint, has a tapered mating edge to permit ready engagement of the aft section. The poppet assembly, spring-loaded in the closed position, includes a pilot valve assembly and a Teflon gasket which forms the seal. Upon disengagement, the forward section seals closed when the gasket on the poppet seats against the ring assembly.

The aft section is composed of a stainless-steel bellows assembly and a spun-aluminum spider. The bellows portion includes a bellows welded between two flanges, the aft drilled for booster fastening and the forward drilled for spider attachment.

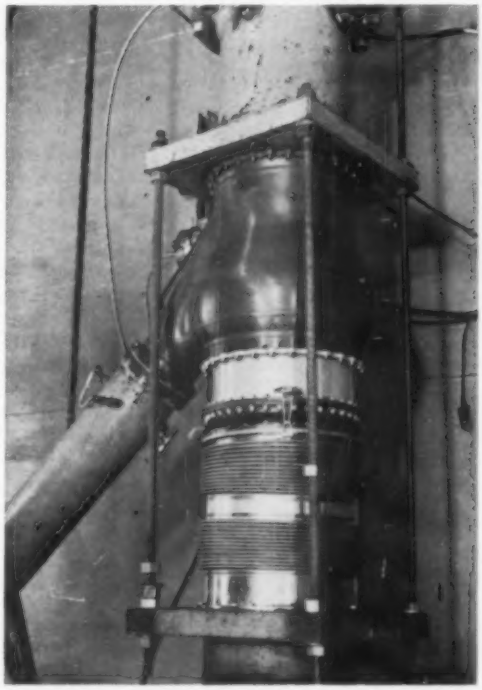
A spirally-wound gasket forms a seal between the spider and bellows. Excessive compression is prevented by positive stops on three stainless rods between the bellows flange and the spider assembly.

• **High flow**—The entire valve has an unusually high total flow capacity of 6500 gpm at 117 psig. The sustainer by-pass has a capacity of 1180 gpm at 117 psig. Flow through both outlets occurs with a pressure drop of 3.8 psi in the booster line and 3.0 psi in the sustainer line. The unit disconnects and separates in 0.04 seconds.

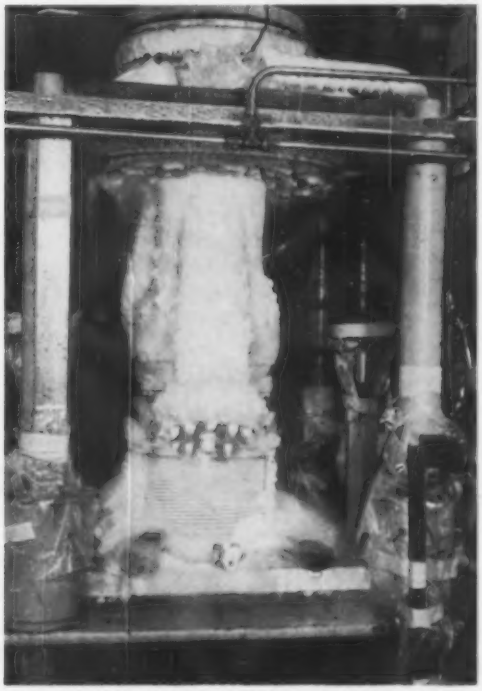
The *Mercury* valve meets Air Force specifications and is an off-the-shelf item. It can be modified to meet other requirements.

The Reaction Motors department produces a complete line of valves including disconnect, shutoff, check, and fill-and-drain. Vent and relief valves, reusable squib valves, universal fluid couplings and gas-pressure regulators fill out the firm's line.

The components have been used in *Viking, Titan, Atlas, Thor,* Project *Mercury, X-15, Redstone, Jupiter C* and in the Bell X-1, BX-1A and MX-774. ¤



LARGEST LOX disconnect valve produced by Reaction Motors has a line diameter of 11 in. The unit is being used in the Mercury-Atlas series.



SEVERE ENVIRONMENTAL testing has paid off in extremely high reliability. Components are subjected to special evaluation testing before delivery.

Dyna-Soar 'picks-off' X-15 hardware...

(Continued from page 14)

part of the job formerly done by the nose boom, providing air flow information. Its main feature is a 5½-in., hollow, nitrogen-cooled shell made of Inconel-X which varies down to ½-in. in thickness. The ball presents five holes—four placed 42 degrees off a center hole—to the air stream. Sensors detect pressure differentials across the holes, and a servo rotates the ball to keep the central orifice lined up with the relative air flow, equalizing pressure on the outer holes. Ball displacement from the aircraft's center line provides angle of attack and yaw information.

Although the critical job of the nose ball is re-entry, it is necessary over the *X-15's* entire flight profile above Mach 3.5. On re-entry, the pilot uses the ball to establish and hold his re-entry angle. Re-entry angles—aircraft angle of attack as measured from direction of air flow—have ranged up to 12 degrees for the *X-15*, depending upon peak altitude.

• **Data lag**—The *X-15*'s inertial platform probably will be the most direct application to *Dyna-Soar*. In addition to inertial attitude, it provides the other data lost when the nose boom was removed—velocity and altitude.

"We couldn't trust the nose boom for air speed, attitude and altitude after the *X-15* reached Mach 3.5 because of boom heating and the *X-15*'s rapid changes in altitude," says one project engineer. "And there was too much lag in obtaining this data."

The inertial platform and the nose ball are tied into the oscillation-damper—the stability augmentation system—which *X-15* pilot John McKay called "the last resort to keep the airplane from breaking up during certain maneuvers."

"What we have found is that it takes such a system to get the pilot through troublesome flight areas," McKay said. "Otherwise, some maneuvers would result in oscillations too great for the pilot to handle." He added that the stability augmentation system, as well as the *X-15*'s design, made the aircraft somewhat easier to fly than the *X-1, X-1B, X-1E,* or *D-558 Skyrocket.*

The *X-15*'s stability augmentation system is unique in that it has a variable gain, or response rate, which is needed because of the aircraft's extremely variable flight condition. The pilot adjusts the gain for altitude, air speed and dynamic pressure, making the aerodynamic controls react slower or faster, as needed.

Love said *Dyna-Soar* would require an improved system which will tie into the ballistic controls (the present system does not) and automatically adjust its own gain with information from the inertial platform and ball nose.

An advanced system, known as an adaptive control system and designed by Minneapolis-Honeywell, is scheduled for installation in the No. 3 *X-15* for October flights. It already has been tested in the *F-101* and *X-15* simulator.

McKay reported the adaptive control system has better fail safe features than the system currently in use, automatically going to a fixed-gain setting to allow the aircraft to return safely in event of system failure.

"The No. 3 *X-15* will test this system for other programs as well as *Dyna-Soar*, including supersonic transport and low-level attack aircraft," Love said. "It's being looked at for a variety of vehicles. It seems to be the general trend."

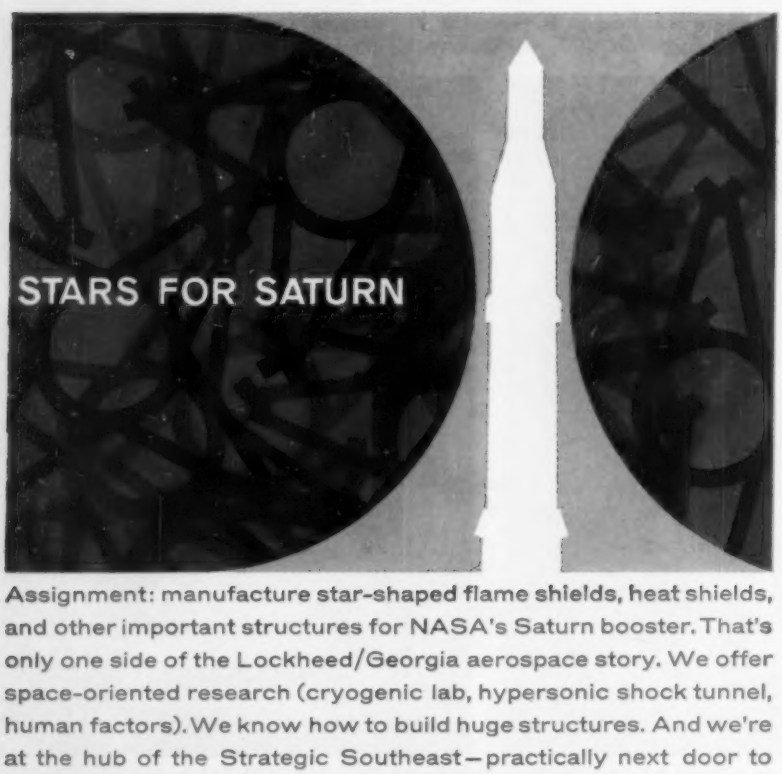
• **Skin problem**—The *X-15*'s side-arm controller concept definitely is slated for *Dyna-Soar* use.

What *Dyna-Soar* will use for skin has not been released, but one *X-15* modification, currently underway, will be noted by the military vehicle's airframe designers. The *X-15's* side fairing panels buckled during a recent mission because of non-uniform temperature stresses. There are four such panels, 2-ft. long triangles, on each side of the fuselage over the liquid oxygen tank forward of the wing. They are fabricated from two pieces of .030 Inconel-X, the inner piece corrugated. The panels are subject to below-freezing temperatures on the inner side and aerodynamic heating on the outside.

The modification involves installation of expansion joints between the panels. The supports to which the panels formerly were riveted now have been V-slotted, and the panels attached with pins which allow a ¼-in. expansion through the slot.

The *X-15* so far has had more trouble with temperature stresses than with air loads, though nothing unexpected or serious. The aircraft is equipped with 650 thermocouples to record how heat flow lags through its structure. In the wings, for example, the temperature might reach 400 degrees F. on the lower surface, drop to zero inside and rise to 200 degrees F. on the top surface. Such differentials, added to air loads, could lead to warping, rivet-shearing and structural failure.

The auxiliary power unit is another



Assignment: manufacture star-shaped flame shields, heat shields, and other important structures for NASA's Saturn booster. That's only one side of the Lockheed/Georgia aerospace story. We offer space-oriented research (cryogenic lab, hypersonic shock tunnel, human factors). We know how to build huge structures. And we're at the hub of the Strategic Southeast—practically next door to Huntsville and Cape Canaveral. LOCKHEED/GEORGIA

Marietta, Georgia

X-15-proven feature that will go into the space bomber. However, *Dyna-Soar* will take advantage of state-of-the-art improvement in hydrogen burning, using hydrogen and liquid oxygen as its APU energy source. The *X-15*'s two APUs operate on steam power produced by hydrogen-peroxide.

One of the main reasons for this difference is that the hydrogen-liquid oxygen system will weigh less. But perhaps even more important to *Dyna-Soar*, the hydrogen-liquid oxygen, kept at −300F., will be used as a heat sink.

• **Wire skids**—Although *Dyna-Soar* will use different landing gear, *X-15* research is providing vital information in that area as well. The *X-15* is equipped for dry lake bed landings, using smooth rear skids and a non-steerable nose wheel, whereas *Dyna-Soar* will use wire brush rear skids and a dish-type front skid for landing on asphalt or concrete runways.

Both *Dyna-Soar* and the *X-15* pilots have been investigating ground steerability during landings, using the aerodynamic controls to shift load to one skid or another for directional control. In the case of the *X-15*, this is being investigated for emergency landing procedures when it might have to land at an alternate dry lake.

Love spiked a recent report that the *X-15* would be used to test *Dyna-Soar*'s brush skids. The brushes will be tested on a truck that will speed up and down a runway. The *X-15* is strictly for dry lake bed landings.

The *X-15* will soon begin testing two new devices that will provide further information, and possibly hardware, for *Dyna-Soar's* pilot environmental system—a radiation counter and a gas analyzer.

The radiation counter is a 15-lb. package developed in-house at the Air Force Special Weapons Center, Kirtland AFB, N.M. It will measure the rate of radiation experienced by the pilot at higher altitudes.

The gas analyzer, developed by Bendix, will be essential equipment on any spacecraft. It will sense and report partial pressure of five known gases—carbon dioxide, carbon monoxide, oxygen, water vapor and nitrogen—and, by scanning atomic numbers, note the presence of any "unknown" gas in the environmental system ¤

Saturn C-2 booster dropped . . .

(Continued from page 13)

becomes operational in time.

NASA is expected to publish the proposed *Saturn* changes once its $1.8 billion appropriation bill clears Congress—expected in about two weeks. Meantime there were these other developments in the *Saturn* program:

There will be no modified *Centaur* third stage on the first generation *Saturn C-1* booster. Since the *C-1* will be used only for development testing and earth orbit shots of *Apollo*, NASA has decided that a two-stage vehicle will be sufficient. Money saved from the cancellation of the *C-2* and the *Centaur* stage will be used to speed up other aspects of the program.

• **C-1 competition**—A bidders conference will be held late this month on construction of some 15 *Saturn C-1* boosters. First developed by the Marshall Space Flight Center, the space agency is now ready to turn construction over to industry.

Competitors for the multi-million dollar prime contract include Convair, Martin, Chance-Vought Aircraft Co., North American Aviation, Boeing, Aeronutronics, and Chrysler.

Although several sites have been studied, Marshall Space Flight Center has decided that the *C-1* should be built at a government owned plant at Michaud, La. The same facility will be used for the production of the *S-1* first stage of the *Saturn C-3*. The plant is not large enough to be used as the construction site for *Nova*.

Space agency officials believe that it is impossible to accelerate the development of the *C-1*. They intend, however, to increase its utilization.

NASA originally expected to use three operational *C-1's* for various *Apollo* missions and its satellite programs. This has been increased to at least six and possibly 10. With 10 vehicles scheduled for use in research and development, this means that about 20 *C-1's* will be built.

• **More Saturn pads**—Construction will begin next month on another *Saturn* launch complex with two pads, and there are plans to bring the total to six. They will be used to cut the development test flight period of the *C-3* from 2½ years for *C-1* to 1½ years.

Contract for the *S-II* second stage of the *C-3* will be awarded within the next two months. Firms in the running include Aerojet, Douglas, North American Aviation and Convair. The contract has been delayed by NASA changes in specifications—including three changes in its diameter.

Perhaps the largest decision expected within the next month concerns just what complex of engines and stages will make up the *Saturn C-3*. A large part of the $224 million earmarked for the *Saturn* program in fiscal 1962 will be spent on *C-3*.

As first conceived the *S-I* first stage was to have two *F-1* engines, which develop a thrust of 1.5 million pounds each. NASA is now considering increasing the number of engines to perhaps four. James Webb, space agency administrator, said recently that he favors a three-engine first stage.

The *S-II* second stage will use Rocketdyne's 200,000 lb. thrust *J-2* engine. The big question is will the stage have four or eight *J-2s*?

The *S-IV* third stage contract has been awarded to Douglas and is scheduled to have six 15,000 lb. *LR-115* engines. There is sentiment within NASA to switch one one *J-2*. If this is done, which appears unlikely, it may be necessary to rebid the contract.

Another still undetermined policy decision is how fast development of the multi-billion lb. thrust *Nova* booster should be pushed. Certain government officials feel that the *Saturn C-3* should be stressed at the present time. Another look could be taken at the *Nova* situation in about a year when some unknowns concerning multi-stage boosters have been cleared up.

Although only $48 million of the space agency's fiscal '62 budget is slated for the liquid *Nova* program, it is expected that a decision will be made to push ahead on both programs. Officials contend the total cost will be only 15 per cent higher.

Expenditure of *Nova* funds in the current fiscal year will be limited to planning and selection of firing and launch sites.

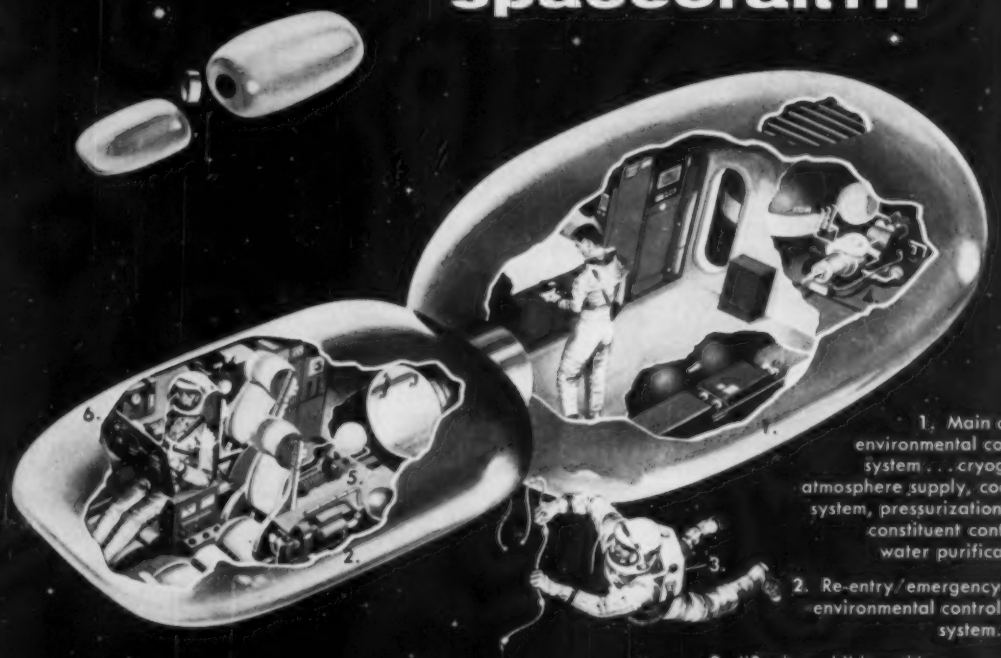
Presently being considered as sites are a great stretch of the Texas Gulf coast and eight or ten other areas in this country and overseas. These include a region within the King Ranch in Texas, White Sands Proving Grounds in New Mexico, the Hawaiian Islands and Christmas Island in the Pacific.

• **First C-1 Launch**—Meanwhile, the space agency began to put into operation plans to launch the first *Saturn C-1* from launch complex 34 at Cape Canaveral. The booster was expected to start its trip down river on a barge either late last week or early this week.

The trip from Huntsville, Ala. to the Cape is expected to take 30 days with the launch set for sometime in October. Ten research and development flights from the Cape are planned with the last four scheduled to test fly the *Apollo* spacecraft.

Marshall Space Flight Center employes have been running the *C-1* through a series of dynamic tests. ¤

Environmental and secondary power systems for multiman spacecraft...



1. Main cabin environmental control system . . . cryogenic atmosphere supply, cooling system, pressurization and constituent controls, water purification.

2. Re-entry/emergency environmental control system.

3. "Back pack" breathing and pressurization system.

4. Secondary power system . . . multiple re-entry turbine, pump, alternator and cryogenic fuel supplies.

5. Attitude control system . . . reaction motor, fuel and attitude controls.

6. Instrumentation . . . flight data and physiological monitoring systems.

Manned space flight requires reliable and efficient thermal and atmospheric systems and secondary power equipment.

Complete and integrated systems, as pictured, are being studied or under development at The Garrett Corporation. Through optimized design they offer an unmatched degree of compatibility and high performance.

Their design reflects Garrett's 20 years of leadership in developing and producing secondary power and environmental controls for aircraft and spacecraft, including NASA's Project Mercury life support system. This unique capability offers an unequaled source of research, development and production to the government and industry.

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at AAS conference . . .

Solar Flare Warning System Unveiled

Lockheed concept could warn of solar bursts far enough in advance to save payloads, warn space crews of danger.

LOCKHEED AIRCRAFT Corp. is offering the Air Force and NASA a project leading to a world wide automatic solar flare warning system for space crews.

Gerald F. Anderson of the Lockheed Solar Observatory, Burbank, Calif. told M/R the proposal is based on recent observational developments which indicate "We are close to a reliable short term method of predicting flare minutes and hours ahead of time."

The ground-based system would be used in an electronic scanning setup to monitor constantly a television image of the sun disk for certain flare indications. Lockheed already has such a monitoring system in operation in Burbank.

While intended primarily to warn these crews of impending deadly outbursts of solar radiation, the system would have an immediate payoff for current satellite research programs.

"In the *Discoverer* satellite program, for instance, they have had experiments wrecked by solar flares," Anderson said, "Emulsion film, radiation counters and telemetering systems have been affected. Scientists would like to recover the payload before this happens. And experimenters in other programs would like to be able to calibrate their satellite instruments to take solar flares into account."

Anderson, who delivered a paper at the American Astronautical Society San Francisco conference, said that a network of four solar monitoring stations around the world could be established for relatively little expense—about $250,000.

The solar flare prediction, using a heliograph equipped with a birefringent filter is based on observation of short term disturbances visible on the sun disk. The disk image may be viewed directly, displayed on a television screen or recorded on a sequence camera which takes one picture every ten seconds.

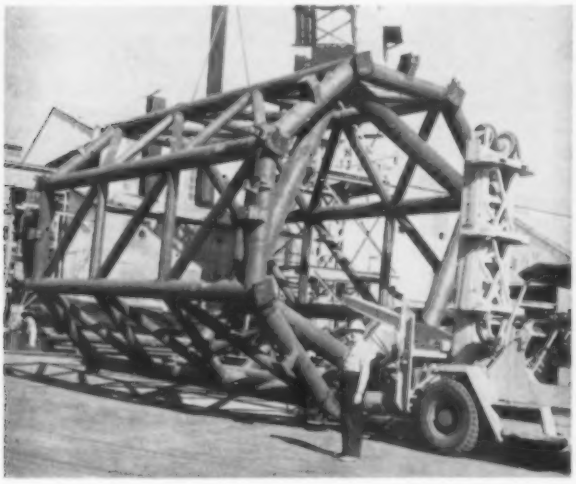
Anderson said he had observed two kinds of disturbances preceding solar flares—a dark crescent shaped area which resembles fingernail marks on the sun's disk, and "filament activations" which appear as small wavy lines.

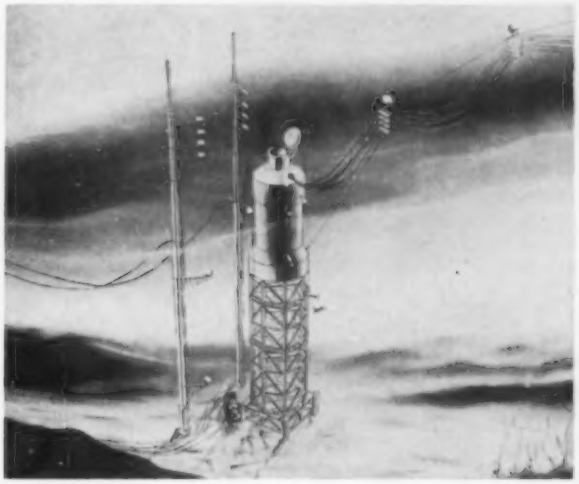
"As you watch, you can see the crescents appear, grow and change shape," he said. "They expand for five or six minutes and then start to break into smaller portions. There are turbulant-like motions. This lasts for a few minutes and then the flare comes. We feel pretty confident that the crescents are disturbances welling up from the sun's lower atmosphere. Flares come up under or very near the crescent."

The filaments, actually the prominences otherwise seen at the edge of the sun's disk, also are associated with flares, sometimes disappear abruptly as little as three minutes before a flare appears nearby.

Anderson said he had not been able to detect advance warning for all flares but that he hoped to do so with the cinematographic system of greater spatial resolution currently under design and construction at the observatory.

Lockheed proposes to establish the system in two steps. In Phase 1, Lockheed would demonstrate for a period of time with an operating system at Burbank. In Phase 2, the stations located around the globe would spend a year taking photographs to demonstrate "seeing" quality before setting up the automatic flare warning system. ⌘





Underwater Polaris Launch Facility

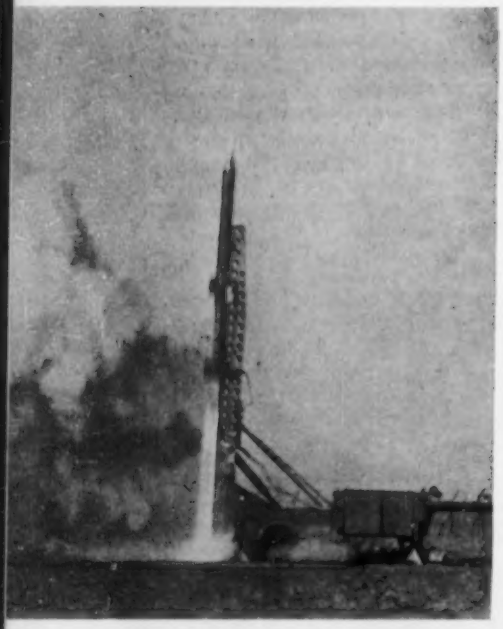
THIRTY-FOOT section of variable depth launcher was fabricated by U.S. Steel's Vernon Plant. Completed facility has been installed at San Clemente Island on the ocean floor and will be used for Polaris testing by NOTS, Pasadena.

ARTIST'S CONCEPTION shows launcher in place at the undersea San Clemente Island Test Range. Movable platforms enable test firing of the Polaris from various depths with high-speed underwater cameras recording trajectory data.

Rocket Power Ranks Abroad Rapidly

M/R survey shows 28 nations now participating in space, missile research; European satellite spurs interest

by Bernard Poirier



***CENTAURE:** Shown being launched from mobile carrier for flight over the Sahara Desert.*

A SURVEY by MISSILES AND ROCKETS shows a total of 28 countries now acquiring rocket power—either themselves or through international agreements.

Most of the rocket effort is military oriented. But a growing number of nations are moving into space research, helped along by the United States and the cooperative European satellite launching project. Canada and Britain hope to join the U.S. and Russia with satellites in orbit next year through NASA's International Programs Division. The space agency will provide the launch vehicle for an all-Canadian made *Alouette* satellite. Britain will provide just the instrumentation for its first orbital venture.

None of the space programs now envisioned will approach the magnitude of either the U.S. or Russia. Nevertheless, the joint European program which brings together Britain, France, West Germany, Italy, Switzerland, Austria, Norway, Denmark, Sweden, Belgium, Netherlands, and Spain promises to cost $200 million.

Britain and France, moreover, are considering a plan advanced by SEREB and the Hawker Siddeley Group to cooperate on a communications satellite system which would be operative by the end of 1964. France disclosed this past week that if this plan falls through, she will orbit a satellite by herself in the same time period.

Israel, Yugoslavia and the United Arab Republic have scientific programs underway which could easily be converted to military systems by substituting warheads for instrumented cones and adjusting launching modes.

• **NATO production** — Belgium, Portugal, Denmark, Greece, Netherlands and Turkey are involved with other NATO partners in joint production of *Sidewinder* and *Hawk* missile systems in Europe. Netherlands excepted, they do not produce rockets on their own but in some cases produce highly complex electronic support equipment. The Dutch are producing SEPR rocket boosters for a new military drone under special license with France.

Norway has developed a complete ASW shipborne missile system using the *Terne* weapon and also participates in NATO missile system production. Sweden has several ship and surface-to-air missiles operational and hopes to start a sounding probe series this year with imported research rockets. She has Hughes *Falcons* deployed and several British missiles for training purposes.

Red China is believed to be manufacturing JATO boosters for Russian supplied jet fighters and has probably developed other rockets.

Madrid sources say the Air Forces Ministry has several missile research projects underway. A group of scientists have launched several small research rockets and a stronger program remains stalled by the lack of national backing for non-military projects.

In Baghdad last month, Iraqi troops had a show of military prowess which included several mobile barrage rocket launchers similar in design to the *HRS* rocket system purchased by Egypt from Italy several years ago. But in the Near East other "neutral" nations are gaining in rocket powered hardware. Iran continues her interest in several systems since the French demonstrated their antitank missiles in Mehrabad last year.

• **UAR joins in**—The imbalance caused by rocket power was demonstrated when Israel launched her *Shavit II* which, according to observers in Tel Aviv, has a 62 mile range tactical version under development. The relatively simple event prompted the United Arab Republic into urgent procurement of American research rockets.

While Israel's initial effort resulted in releasing a sodium cloud at an extreme altitude the implication that Israel had achieved rocket power as an instrument of war caused an instant response in Cairo.

The UAR imitated Israel and cited peaceful applications for the newly acquired rockets. No public mention was made by the UAR of the rocket studies at Heliopolis which have been pursued for several years by Egyptian scientists attached to C.E.R.V.A., Company for Accelerated Flight by Reaction Vehicles.

Although the U.S. and the USSR dominate the field, France and England are neck and neck on overall development for third place and the remainder trail behind at various levels. Considering size and population several nations are making outstanding contributions.

• **Down-under research**—Australia

Increasing

has her own research rockets and has a major installation to support NASA's man-in-space program. Canada is developing the *Black Brant* rocket series and her *Alouette* satellite will be orbited by NASA early in 1962. Canada has no military missile programs of her own but Australia has its *Malkara* antitank missile.

Japan's outstanding research program is centered in the Itokawa Laboratory at Tokyo University while its Defense Ministry manages all military missile research and production. Professor Itokawa's best effort to date occurred April 1, 1961 when the new *Kappa 9* was successfully launched at Japan's Akita Test Site and all three stages ignited perfectly for an ionospheric sounding at 250 miles altitude.

Yugoslavia purchased $277,000 worth of earlier *Kappa 6* rockets and necessary ground support equipment as its first build-up of a national effort in rocket know-how. Even remote Burma is making a pitch for Japanese research vehicles as is Australia and Argentina which has several successful rockets of its own.

Britain has the only inertial guidance systems in operational missiles outside the U.S. and USSR. On the research side, Britain has used the *Skylark* more than any other vehicle. A recent shot released a sodium vapor cloud at 110 miles over Woomera, Australia, and plans now call for ultraviolet photos of stars utilizing the *Skylark* in a program financed by the Royal Observatory, Edinburgh.

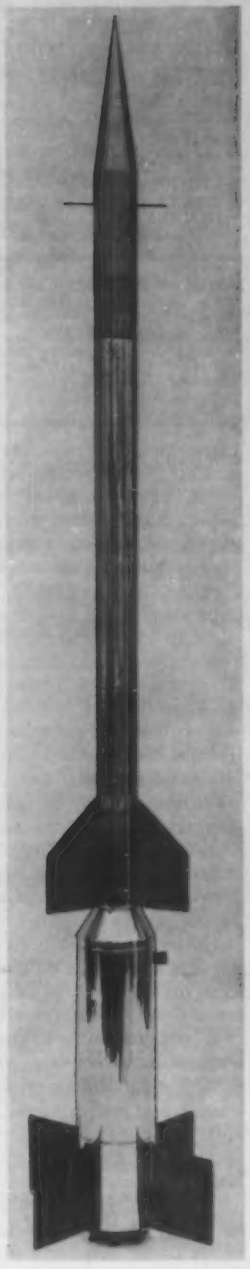
Australia is joining Britain in development of the new 40 ft. *Jaguar*. Royal Aircraft Establishment, Farnborough will build the first stage and Australia's Department of Supply will produce the second and third stages.

Deutsche Raketengesellshaft of Bremen fired mail carrying rockets and in June, West Germany's first off-the-shelf research rocket was unveiled at the Paris Air Show as an added attraction to Bolkow's *Cobra* antitank missile.

• **French research**—France's D.E.F.A. *Véronique* may soon be replaced by new vehicles produced by French industry. Sud Aviation's two-stage, solid *Centaure* with C.N.E.T. instrumentation carried 70 lbs. to 85 miles altitude in a series of recent tests and newer Sud *Dragon* and *Pegase* rockets will

***CENTAURE:** Closeup of Sud's rocket equipped with special booster and Ram second stage.*

***KAPPA 9:** Fired for first time on April 1, reached 250 miles over Japan's Akita Range.*



***AEOLUS:** Australian research rocket will carry 30 lbs. up to 240,000 ft. altitude.*

Nations Developing Rocket or Space Systems

Country	Military	Scientific	Space Systems	Space Support
1. ARGENTINA	X*	X*		
2. AUSTRALIA	X*	X*		X
3. CANADA		X*	X	
4. FRANCE	X*	X*	X	X
5. INDIA	X	X		
6. IRAQ	X*			
7. ISRAEL	X	X		
8. ITALY	X*	X		
9. JAPAN	X	X*	X	X
10. NORWAY	X*			
11. POLAND		X*		
12. RED CHINA	X	X		
13. SPAIN	X	X		
14. SWEDEN	X*	X		
15. SWITZERLAND	X*			
16. UNITED ARAB REP.	X	X		
17. UNITED KINGDOM	X*	X*	X	X
18. U.S.A.	X*	X*	X*	X*
19. U.S.S.R.	X*	X*	X*	X*
20 WEST GERMANY	X*	X		
21. YUGOSLAVIA	X	X		

Note: *—Operational System(s)

Nations Participating in NATO Missile Production Only

22. BELGIUM
23. DENMARK
24. GREECE
25. NETHERLANDS
26. TURKEY
27. PORTUGAL
28. NEW ZEALAND—has several missile destroyers under construction but the missile systems are British. (SEATO)

carry identical payloads to 250 miles and 600 miles respectively.

A 1760 lb. solid "Stromboli" propellant booster destined for *Dragon* and *Pegase* was also recently proven at Hammaguir. In June an experimental *Agathe* with a 4000 lb. *Mammouth I* solid stage lifted 1500 lbs. of test equipment to 160,000 feet. The payload was recovered by parachute over the desert. *Mammouth III* will have a standard 265 lb. instrumented payload for the deepest probes yet scheduled in Europe—1000 miles.

Another newcomer is *Bérénice*, an improved *Antarès* by O.N.E.R.A. It has two versions, the III and the IV—for number of stages. *Bérénice IV* has been described by Maurice Roy, O.N.E.R.A. Director, as capable of carrying a 132 lb. capsule to 600 miles altitude.

Military applications are suggested for the four stage *Bérénice* as was the case for the *Antarès*. Multichannel data on its Mach 12 reentry performance will be valuable for France's IRBM program directed by the national S.E.R.-E.B. agency. *Bérénice* will be the first long range rocket with "some form of internal guidance" in the first and perhaps the second stages, say Paris sources. These tests may herald inertial guidance for French military missiles.

Italy also has an IRBM program study under way for a 900 mile vehicle. The only announcement identified Ministero Difensa Aeronautica as program coordinator but it has been routine for SISPRE, Bombrini-Parodi Delfino and other leaders of Italian rocket development to be involved in all national programs.

These same firms are associated with Contraves Italiana, S.p.A. in developing research hardware for Italy's new space program directed by the Italian Committee on Space Research Council.

NASA's International Programs Division gave Italy a helping hand by inaugurating a probe program from Perdasdefuego Rocket Range on Sardinia using *Nike-Cajuns*. Some vehicles since then have included an Italian *C-7* as the third stage. The most recent Sardinia joint tests were concluded in July.

• **Minor efforts**—The most modest scientific programs are in Spain, Yugoslavia and India. Although sources in New Delhi insist the Air Force Ministry has several missile research projects the only announced launchings have been efforts by the India Astronautical Society which receives little national support. The best IAS effort has been a 5 lb. transmitter aboard a rocket which reached about 90 miles. A dozen receiving stations in southern India studied ballistic behavior. A new two stage rocket fueled by a plastic-derived propellant is next to be tested.

The Swiss army uses operational *Mosquito* antitank missiles. The main emphasis has been on Contraves/Oerlikon surface-to-air versions which attract overseas buyers. Systems are in Japan and Italy. For their own anti-aircraft use, the Swiss recently placed a multi-million dollar order for Bristol/Ferranti *Bloodhound II*'s.

In the southern hemisphere, New Zealand plans several missile destroyers but armament will be procured in Britain. The New Zealand Navy chose the Short Brothers ship-to-air *Seacat* as West Germany has done. Argentina is coordinating its naval propellant production with Air Force metallurgical programs apparently under a central Space study agency. Her own multi-stage research rockets along with imported American rockets have been launched this summer at Cordoba in the interior.

Australia has one of the largest overseas ground support stations as part of NASA's man-in-space program. Moreover officials at the Woomera range have admitted official discussion on the feasibility of satellite launchings from Australia.

Japan has appropriated funds to take part in a joint space project with NASA but no definite program has yet been announced. There is Japanese pressure building to increase the *Kappa* project to include a satellite carrier rocket within the next few years. ¤

Ablative Material

(Continued from page 26)

In sub-scale rocket motor tests, the materials have performed well. Both forms of phenolic resin have shown low erosion rate and thermal conductivity.

The amorphous materials are not ignited by open flame and have an emissivity of 0.9. Specific gravity is 1.3 to 1.5.

Sterry said the HITCO-C series is designed to combat the major problem of spalling and other detrimental erosive effects.

Reinforced plastics now being used in rocket vehicles as nose cones, blast tubes and exit cones are selected on the basis of characteristics fitting them for specific applications—one of the most popular being graphite fiber phenolic-resin molding compounds.

• **Where most fail**—The resulting composite structures have high erosion resistance and high conductivity through the graphite phase, according to Sterry, and their conductivity contributes to spalling, thus reducing reliability in the component.

The high mean temperature resulting from conductivity induces high thermal expansion, which is resisted by the backup structure—usually a low-conductivity material. This restrained expansion creates high stresses that produce spalling—a condition in which chunks of material are ejected from the aeffcted surface of the component.

"In random fiber or chopped fabric compounds, another phenomenon can occur," said Sterry, "because the individual fibers conduct quite a bit of heat into the interior of the resin mass, which pyrolizes and evolves gases which build up pressure and eventually explode or spall off volumes of the surface material." ¤

contracts

NASA

$589,026—**Pratt & Whitney Aircraft Div., United Aircraft Corp.**, Middletown, Conn., for space radiator and condenser research facility.

$500,000—**Siegler Corp., Hallamore Div.**, Anaheim, Calif., for design and production of advanced communications systems for Goldstone space vehicle tracking system.

$300,000—**P&W Aircraft Div., United Aircraft Corp.**, E. Hartford, Conn., for design and development of 250-watt H_2-O_2 fuel-cell powerplant system for Lewis Research Center.

$122,075—**A&C Div., Consolidated Electrodynamics Corp.**, Columbus, Ohio, for mass spectrometer for Lewis Research Center.

MISCELLANEOUS

$180,000—**Cubic Corp.**, San Diego, from GE's Missile and Space Vehicle Dept., for production quantities of ultra-high-frequency rate beacon for Project *Advent*.

$58,000—**Chance Vought Corp., Astronautics Div.**, Dallas, for development of a small, self-maneuvering pack for individual crewman to wear to assemble space stations in orbit.

NAVY

$4,450,000—**Avco's Electronics and Ordnance Div.**, Cincinnati, Ohio, for arming and fuzing development for the *Polaris* missile.

$1,816,000—**Raytheon Co.**, Lexington, Mass., for electronics portion of guidance systems for advanced *Polaris* missiles.

$334,765—**Aeronca Mfg. Corp.**, Middletown, Ohio, for 115 targets similar to *Pogo-Hi* (less rocket motor and rocket fins) and 215 sets of tail fins for use with same and *Beacon I* rocket motor.

$188,350 — **Minneapolis-Honeywell Regulator Co.**, Hopkins, Minn., for *Little John* rocket trainer, Phase II.

$97,683—**Tasker Instruments Corp.**, Van Nuys, Calif., for services, labor and materials to fabricate guided-missile launcher test sets.

AIR FORCE

$50,000,000—**Hercules Powder Co.**, Wilmington, Del., for research and development on *Minuteman* third-stage propulsion unit, and delivery of several flight-test motors for the rocket to Cape Canaveral.

$28,500,000—**Avco's Electronics and Ordnance Div.**, Cincinnati, Ohio, for production of FPS-26 height finder radar.

$1,500,000—**Radio Engineering Laboratories**, Long Island City, N.Y.,, for tropospheric scatter equipment.

$878,500—**Marquardt Corp.**, Ogden, Utah, for mobile ramjet test sets, 5 ea., required data and spare parts for *Bomarc* missiles.

$800,000—**Beech Aircraft Corp.**, Boulder, Colo. Division, for two types of semi-trailers capable of transporting the fuel and oxidizer for the *Titan II* ICBM program.

$700,000—**Radiation, Inc.**, Melbourne, Fla., from **The Boeing Co.**, for *Minuteman* ground telemetry equipment.

$406,602—**Bechtel Corp.**, San Francisco, for research and theoretical studies of alternative general configuration of a large vacuum chamber and ancillary equipment.

$386,000—**RCA Service Co., division of RCA**, Camden, N.J., for research studies and development of prototype solar simulator.

$250,000—**Atlantic Research Corp.**, Alexandria, Va., from Edwards AFB Flight Test Center, for work in field of multi-component fuels for rockets and ramjets.

ARMY

$70,685,283—**The Martin Co.**, Orlando, Fla., for completion of the test program, advanced phase; and production of *Pershing* weapon. (Two contracts.)

$11,005,269—**The Martin Co.**, Orlando, Fla., for *Pershing* weapon system. (9 contracts).

$6,327,886—**Convair/General Dynamics Corp.**, Pomona, Calif., for development of *Mauler* guided missile system. (3 contracts).

$6,258,314—**Sperry Rand Corp.**, Salt Lake City Utah, for furnishing and delivering repair parts for *Sergeant* guided missile system.

$4,746,525—**Philco Corp.**, Washington, Pa., for services and materials to engineer, furnish, install and test a complete operational communication system.

$3,957,124—**Nortronics Div., Northrop Corp.**, Anaheim, Calif., for *Hawk* launchers.

$2,999,986—**Nortronics Div., Northrop Corp.**, Hawthorne, Calif., for arming decision device.

$2,803,946—**Sperry Rand Corp.**, Salt Lake City, Utah, for research and development on *Sergeant* missile system.

$2,174,907—**Western Electric Co.**, New York City, for procurement of *Nike* replenishment spare parts. (6 contracts).

$2,120,365—**Missile Products Div., Freuhauf Trailer Co.**, Los Angeles, for basic enclosure and trailer frame assembly.

$1,819,150—**Sperry Rand Corp.**, Salt Lake City, for arming decision device.

$1,621,274—**AiResearch Mfg. Co. of Arizona**, Phoenix, for engine for *Sergeant* missile system.

$1,211,453—**Aerojet General Corp.**, Covina, Calif., for instrumentation and installation for missile system and solid propellants.

$1,076,826—**Alpha Corp.**, Richardson, Tex., for installation of a high-frequency radio communications system. (2 contracts).

$992,356—**Hughes Aircraft Corp.**, Fullerton, Calif., for radar tracking stations and services and materials to integrate with modified AN/TSQ-38.

$889,145—**Radioplane Div., Northrop Corp.**, Van Nuys, Calif., for repair parts for target missile. (2 contracts).

$759,786—**The Martin Co.**, Orlando, Fla., for procurement of replenishment spare parts and concurrent repair parts and modification kits for *Lacrosse* missile system. (5 contracts).

$743,764—**Fairchild Camera & Instrument Co.**, Syosset, L.I., N.Y., for delivery and integration of PTS with *SD-2* drone systems.

$721,009—**The Hayes Corp.**, Birmingham, Ala., for *Pershing* missile trainers.

$720,000—**Fairchild Aircraft & Missiles Div.**, Hagerstown, Md., for long-range drone surveillance system.

$600,000—**Bendix Systems Div., Bendix Corp.**, Ann Arbor, Mich., for ground-based electronic equipment for Project *Advent* shipboard terminal.

$600,000—**Equipment Div., Raytheon Co.**, Norwood, Mass., for modification of pulse code modulation system.

$388,721—**Sperry Rand Corp.**, Salt Lake City, Utah, for telemetering equipment.

$371,602—**Convair/General Dynamics Corp.**, Pomona, Calif., for research and development of *Redeye* system.

$315,850—**Packard Bell Computer Corp.**, Los Angeles, for design, fabrication and installation of high analog-to-digital system.

$281,139—**Sperry Rand Corp.**, Salt Lake City, for engineering services on *Sergeant* missile system.

$279,258—**Sperry Rand Corp.**, Salt Lake City, for *Sergeant* ground-handling and test equipment. (3 contracts).

$264,330—**Southern Associated Engineers, Inc.**, Huntsville, Ala, for technical reports related to various missile systems.

$185,000—**Datatrol Corp.**, Silver Spring, Md., for systems analysis and programming services.

$144,390—**Douglas Aircraft Co.**, Santa Monica, Calif., for *Nike-Hercules* launching equipment.

$139,965—**Sperry Rand Corp.**, Salt Lake City, for instructors on *Sergeant* missile system.

$99,429—**Aerojet-General Corp.**, Downey, Calif., for warheads for modification of *Nike-Hercules* missile.

REQUESTS

National Aeronautics and Space Administration, Langley Research Center, Langley Air Force Base, Va.

Design, Development and Fabrication of Heat Shield Assemblies Including Payload Fairings Despin and Separator Mechanisms for Solar Internal Power Project.

The NASA Procurement Office, Langley Research Center, has issued a request for proposal numbered L-1760 to acquire delivery of the above-noted heat shield assemblies in a quantity of 3 for use in testing certain payloads during weightless flight in space using multi-stage booster rocket vehicles.

Proposals are due to be received at the NASA Procurement Office, Langley Research Center, Langley Air Force Base, Va., by 4:30 p.m., August 25, 1961.

The following firms have been invited to participate: Fairchild Aircraft and Missile Div., Hagerstown 10, Md., Attn: Stanford Chester—Douglas Aircraft Co., Inc., 3000 Ocean Park Blvd., Santa Monica, Calif.—Atlantic Research Corp., Space Vehicles Group, Pasadena, Calif.—Texas Instruments, Inc., 6000 Lemmon Ave., Dallas 9, Tex.—Chance Vought Corp., Vought Astronautics Div., P. O. Box 5907, Dallas 22, Tex.—Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.—Douglas Aircraft Co., Inc., 2000 W. Memorial Dr., Tulsa, Okla, Attn: L. C. Raburn—Thiokol Chemical Corp., Hunter-Bristol Div., Bristol, Pa.—North American Aviation, Inc., Space and Information Systems Div., Downey, Calif.—Bell Aerosystems Corp., Buffalo 5, N.Y.—Republic Aviation Corp., Missile Systems Div., Mineola, L. I., N. Y.—Hughes Aircraft Corp., Culver City, Calif.—Cubic Corp., 5575 Kearney Villa Rd., San Diego 11, Calif.—Systems Laboratories Corp., 14852 Ventura Blvd., Sherman Oaks, Calif.—Advance Industries, Inc., 640 Memorial Drive, Cambridge, Mass.—Systems Corp. of America, 1007 Broxton Ave., Los Angeles 24, Calif.—H. Koch & Sons, Inc., P. O. Box 127, Corte Madera, Calif.

NASA suggests that small business firms or others interested in subcontracting opportunities make direct contact with the above firms.

National Aeronautics and Space Administration, Langley Air Force Base, Va.

Design Fabrication Strain Gaging Proof calibrating strain gage-type force measuring balance.

The NASA Procurement Office, Langley Research Center, has issued a request for proposal numbered L-1730 to acquire delivery of above-noted strain gage balances in quantities of 5 or 7 for use in Research and development work at Langley Air Force Base, Va. These strain gage balances will be used in small hypersonic high stagnation temperature tunnels.

Proposals are due to be received at the NASA Procurement Office, Langley Research Center, Langley Air Force Base, Va., by 4:30 p.m., August 14, 1961.

The following firms have been invited to participate:

Allegany Instrument Co., 1091 Wills Mountain, Cumberland, Md., Attn: G. William Harrison, Gen. Mgr.—Chance Vought Corp., Vought Astronautics Div., P. O. Box 5907, Dallas 22, Tex.—Convair Div. of General Dynamics, Ft. Worth, Tex., Attn: J. H. Schlicher, Dept. 6—Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y., Attn: Saul Ferdman—Lockheed Aircraft Corp., Burbank, Calif., Attn: B. D. O'Laughlin—North American Aviation, Inc., Los Angeles Div., International Airport, Los Angeles, Attn: R. P. Davie, Group Leader, Aero-Thermo Models—Task Corp., 1009 E. Vermont Ave., Anaheim, Calif.—Lesslells and Associates, Inc., 916 Commonwealth Ave., Boston 15, Mass., Attn: R. F. Brodrick—Dynametrics Corp., Northwest Industrial Park, Burlington, Mass.

NASA suggests that small business firms or others interested in subcontracting opportunities make direct contact with the above firms.

missiles and rockets
4th Annual

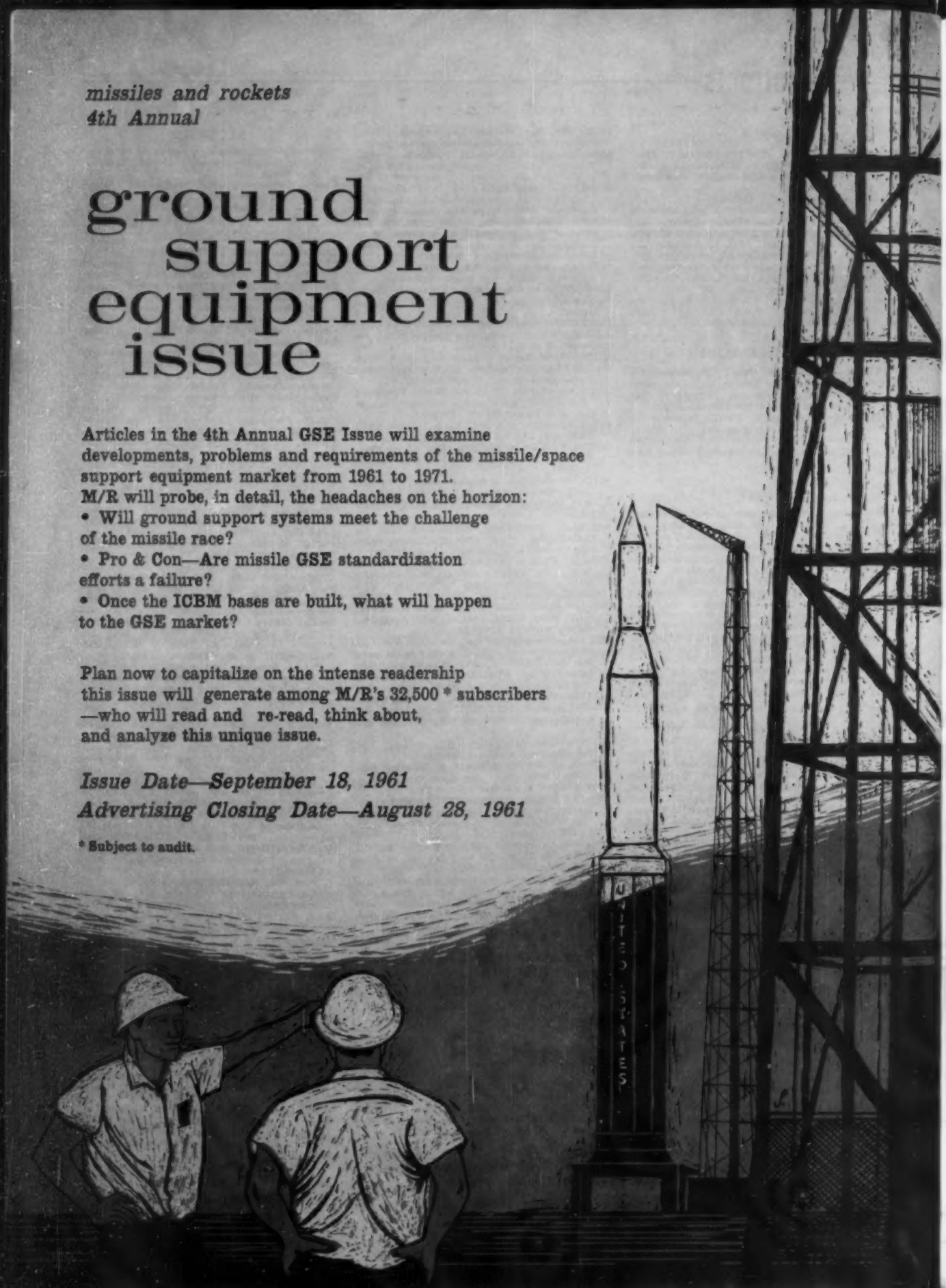
ground support equipment issue

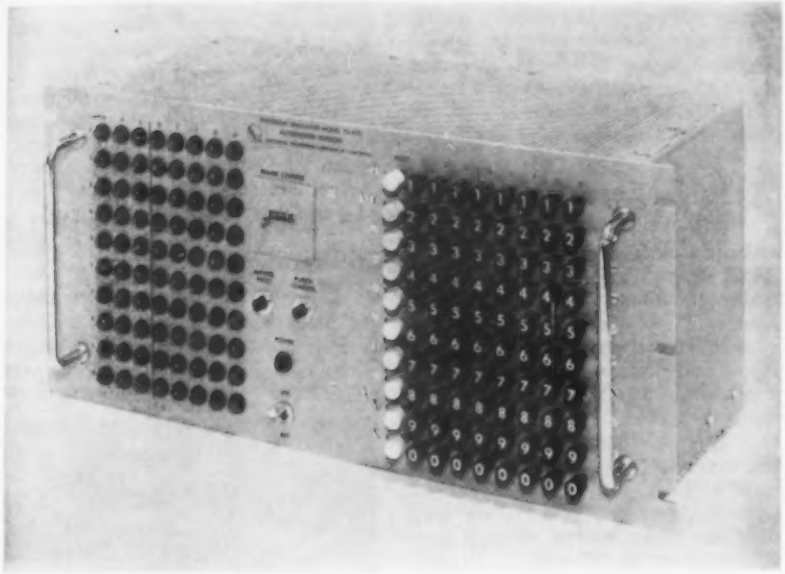
Articles in the 4th Annual GSE Issue will examine developments, problems and requirements of the missile/space support equipment market from 1961 to 1971.
M/R will probe, in detail, the headaches on the horizon:
- **Will ground support systems meet the challenge of the missile race?**
- **Pro & Con—Are missile GSE standardization efforts a failure?**
- **Once the ICBM bases are built, what will happen to the GSE market?**

Plan now to capitalize on the intense readership this issue will generate among M/R's 32,500 * subscribers —who will read and re-read, think about, and analyze this unique issue.

Issue Date—September 18, 1961
Advertising Closing Date—August 28, 1961

*** Subject to audit.**





Manual/Automatic Program Simulator

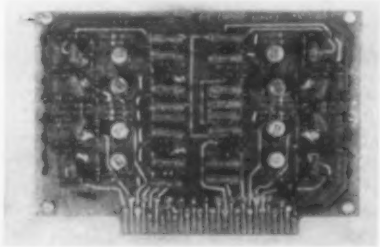
A program simulator which combines manual programing and automatic punch control is available from the Automation Division of the Electronic Engineering Co. The PS-425 Program Simulator is an integrated manual programer and automatic punch control for creation of automatic program tapes in automation equipment. Transfer of the test configuration automatically from the simulator to the punched tape is accomplished without the preparation of a punching chart.

The PS-425 may be substituted for a TP-400 series tape reader to allow manual setup and crosscheck of a desired test configuration prior to punching of a tape. The PS-425 will eliminate blind punching errors in complex programs. The program simulator is supplied in an 80-bit configuration, while the PS-426 is a 96-bit configuration and the PS-427 is a 120-bit model.

Circle No. 225 on Subscriber Service Card

Reversible Decade Counter

A reversible decade counter, capable of integrating both plus or minus pulses at rates up to 150 kc, may now be readily assembled by interconnecting two or more Model CM-105 binary-decimal reversible counter circuit modules available from Circuit Structures Lab. The Model CM-105 units, part of a series of digital building blocks supplied by CSL, each consist of a single printed-circuit card carrying a four-stage binary decimal counter and the necessary control circuits to perform both forward and backward counting operations. Each card also includes logic circuits that provide forward and reverse carry signals to adjacent counter cards.



Circle No. 226 on Subscriber Service Card

Miniature Mixer Amplifier

Astronautics, Inc. has available a high-amplification, three-stage, feedback audio amplifier designed for guided missile, aircraft and similar application. Designated Model AGA-100-002, it meets all applicable military specifications and all of its components are accessible for visual inspection. Its output voltage is adjustable by an accessible potentiometer. A switch is available for grounding the amplifier's input, and two test points are provided for output and input voltage measurement. The company says the unit is not susceptible to the salt conditions of Atlantic or Pacific Missile Range operations.

Circle No. 227 on Subscriber Service Card

Recording Oscillograph

Minneapolis-Honeywell's Heiland division has introduced a direct-recording oscillograph with an optional built-in flash tube timer that produces full-width time lines on recording paper at any of three intervals. The Visicorder 906C employs a timing circuit that can be triggered externally by either supplying pulsing voltage of 10v at 20K ohms impedance, or by causing impedance to drop to 100 ohms or less through shorting-out or other means.

Circle No. 228 on Subscriber Service Card

Symbol Generator

A solid-state character generator has been developed by RMS Associates, Inc. It combines continuous straight and curved lines to form all digits, all letters and many symbols in a fully transistorized compact package. The Curvi-

line can be used with any cathode ray tube display. High character writing rates for the full alphanumeric unit (to 50,000 characters per second, standard) are obtained by forming all symbols from simple formats. Curved lines prevent confusion between similar letters and digits such as the B and 8, the 5 and S and the D and O.

Circle No. 229 on Subscriber Service Card

Dual Attenuator

A combination power attenuator and non-inductive resistance load bank is being introduced by Seco Electronics Inc. The Model 511A attenuator is of typical "T" pad design. Maximum power dissipation rating at the input connector is 50 watts. It is particularly useful where a power amplifier is being used to drive a second amplifier having lower power drive requirements.

Circle No. 230 on Subscriber Service Card

Strain Indicator

Metrix, Inc. is marketing portable transistorized strain indicators. The Model PS7-LT operates from self-contained batteries or external a-c supply, and offers features found in no other

single instrument used for strain measurement. Using integral controls it is possible to balance the measurement bridge, after which strain is read directly from the instrument. Multi-point and long-term strain measurements are also possible.

Circle No. 231 on Subscriber Service Card

Microwave Oscillator

The Instrument Division of Laboratory for Electronics, Inc. is marketing an ultra-stable microwave oscillator, model 814-L-9, for applications in missile and satellite telemetry. The instrument is designed to exceed requirements recently established by the Range Commanders' Conference on Telemetry Standards (Document No. 106-60) which call for frequency stability in the 2200 to 2300 mc telemetry band of 0.005% for transmitters and 0.001% for receivers. The 814-L-9 brackets the telemetry band with a tunable frequency range of 2000 to 2500 mc/s, and has a short-term stability of five parts in 10^8 and long-term stability of one part in 10^6. The dial is calibrated in one mc/s divisions with an accuracy of 0.1% absolute.

Circle No. 232 on Subscriber Service Card

Missile Battery

The Missile Battery Division of the Electric Storage Battery Co. is marketing a low-weight, small-size silver-zinc primary battery for missile application. The 24-volt Model 79 battery automatically activates within one second and has a discharge time of 0.83 minute, when discharged at 10 amperes. It has a capacity of 0.14 ampere-hour and delivers 3.06 watt-hrs./lb. and 0.19 watt-hr. per cu. in. The primary battery performs reliably at altitudes up to 50,000 ft. within the temperature range of −65° to 160°F at any position of the missile.

Circle No. 233 on Subscriber Service Card

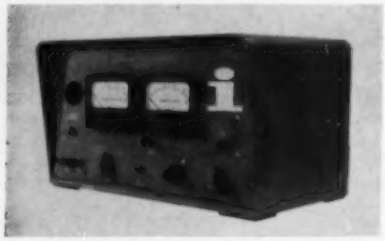
Hydraulic Servo Systems

Hydraulic servo actuator systems developed by Vickers, Inc., Division of Sperry Rand Corp. represent a new concept in tuning microwave tube oscillators. A complete system, including a linear servo actuator, hydraulic power supply and electronic controls, can tune a microwave tube through its frequency range at a constant or variable sweep rate. It is capable of following rapidly and accurately any wave, ramp or step input within its response characteristics. Control power requirements are minimal; the Vickers servo valve requires control power of 0.1 watt.

Circle No. 234 on Subscriber Service Card

Vacuum Gauge Control

Ilikon Corp. is marketing an ultrahigh vacuum gauge control which combines an extended pressure range with automatic emission current control. Model 1020 can be used with any commercially available ultrahigh vacuum gauge to provide linear, stable measurement readings throughout the pressure range of 10^{-3} to 10^{-12} mm. hg. In addition, the emission current can be pre-set and automatically controlled throughout long-term pressure readings. The emission current is variable from 0 ma to 10 ma, and stable to within 2%.



Circle No. 235 on Subscriber Service Card

Surge Suppressor

Overvoltage protection for silicon and germanium cells, controlled rectifier cells, and similar devices is provided by a surge suppressor, called Voltrap, available from the Westinghouse Electric Corp. Because of its Zener-type volt-ampere characteristic, the protective device provides a shunt path for transient overvoltages and imposes a ceiling above which the surge voltage cannot rise. This permits the use of silicon cells without subjecting them to overvoltage, providing the cells have a peak-voltage rating above the clamping voltage of the surge suppressor. The Voltrap surge suppressors include polarized and nonpolarized units, multiple assemblies of polarized and nonpolarized units, and special nonstandard units, and have rating ranges of 2 to 85 amperes maximum discharge current and 30 to 480 a-c rms volts.

Circle No. 236 on Subscriber Service Card

Teflon Slip Rings

A line of teflon slip ring assemblies available from Electro-Tec Corp. are capable of handling very high voltages without characteristic arcing damage even under operating conditions of extreme humidity. At the same time they maintain very high resistance between circuits and offer extreme inertness throughout temperature range of −200°C to 200°C.

Circle No. 237 on Subscriber Service Card

High-Pressure Microfilter

Fluid Dynamics Inc. is producing a "T"-type high-pressure microfilter with greatly increased capacity and much lower pressure drop than standard designs. In average-sized units, rated capacity is boosted as much as 25%. In large units the gain is even greater. Units operate at pressures up to 10,000 psi. They remove particles ranging in size as desired from 100 down to 2 microns. The offset of the outlet port has the further advantage of prolonging element life. It allows the top flange of the element to be designed as a conical "splash" plate. This feature dispenses the fluid more evenly around the element and prevents local overloading.

Circle No. 238 on Subscriber Service Card

Microminiature Connectors

Omega Precision, Inc. is marketing a line of microminiature multi-pin connectors featuring a unique key pin arrangement which eliminates mismating of contacts. Incorporating resilient inserts and potted back ends, units are highly resistant to vibration, shock and

moisture. Contacts are crimped onto wires, and inserted into connector bodies after crimping—a construction which meets applicable test requirements of MIL-C-26636. To provide positive holding power, units employ Omega "Tran-Grip" sockets, which are widely used in solderless mounting of components to printed circuit boards.

Circle No. 239 on Subscriber Service Card

Digital Logic Modules

The Data Systems Division of Harman-Kardon, Inc. has announced the availability for stock delivery of the Series 200 Encapsulated Digital Logic Modules. The modules are rated for operation over the frequency range d-c to 250 kc, and all units are designed by the "worst-case" design technique for operation over the MIL-E-5272 D temperature range (−54°C to +71°C). Constructed by the "bundle board" construction technique, each module is epoxy-encapsulated in a color-coded epoxy shell, of standard modular dimensions.

Circle No. 240 on Subscriber Service Card

36-Unit Switch Panel

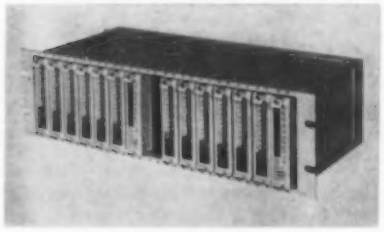
A compact switching panel with 36 miniature, interlocking switches is available from Pepco, Inc. Switches are set in 3 rows of 12 with a barrier between each push-button. The panel also holds a master release button that must be depressed before any of the other 36 keys are depressed. All interlocking is mechanical, to provide maximum reliability. The interlocking action may be varied to provide positive or momentary locking for individual rows or groups.

Circle No. 241 on Subscriber Service Card

Pulse Counting Systems

A dual-channel, 10 megacycle pulse counting system is available from Harvey-Wells Electronics, Inc., as a standard product. The HW system consists of two separate 7-decade, 10-megacycle pulse counting units in a standard HW data-bloc module bay. Each channel consists of a single 10-megacycle HW decade scaler followed by six one-megacycle HW scalers. Carry pulses from decade to decade are transferred by means of front panel jumper connections.

Circle No. 242 on Subscriber Service Card



Photoelectric Reader

Melpar, Inc. is marketing a highly sensitive, miniaturized photoelectric reader. The Model 150 Reader, combining a light source, lens and photocell in a single unit, was designed for use in automatic control systems using electronic circuits which operate as a function of reflected light. At a distance of ⅛ in. from the lens a resistance range of approximately 25,000 to 250,000 ohms is available, with light reflection from white to black surfaces.

Circle No. 243 on Subscriber Service Card

Rotary Solenoids

A solenoid originally designed to operate rotary switches in high-power circuits used in missile and rocket applications is now being applied to the specific requirements of military and commercial manufacturers by Singer-Bridgeport, a division of The Singer Manufacturing Co. The solenoid action, being a pure rotation of a balanced rotor, requires no linkages to convert linear motion to rotary and, therefore, is inherently resistant to mechanical environments such as axial vibration and shock.

Circle No. 244 on Subscriber Service Card

new literature

BUWEPS GUIDE—Designed as a compact, authoritative aid to all sales and engineering representatives, a pocket guide to BuWeps has been published by Defense Information, Inc. Featured are comprehensive explanations of the entire BuWeps organization, basic responsibilities of subdivisions, budget and funding information broken down from primary appropriations areas to the programed funding in codes and a complete list of personnel with locations.

Circle No. 200 on Subscriber Service Card

POWER PACKS—Electronic Research Associates, Inc. has published a two-page bulletin containing detailed mechanical data on their complete line of Transpac miniaturized power packs. Included is case-size data, tolerances, terminal connections, mounting information, and related data. Drawings covering case sizes and terminal orientation are included.

Circle No. 201 on Subscriber Service Card

PRECISION WELDING—A generation of precision resistance-welding power supplies featuring solid-state design, dual watt-second ranges and optional voltage regulation, and based on the asymptotic charging principle, is described in a catalog available from Weldmatic Division/Unitek. Power-matched welding heads range from ultrasensitive units for interconnecting component leads in assembly of miniature electronic circuit modules to heavier-duty, more versatile models used in a wide variety of metal joining applications including the joining of lead wires to potentiometers, relays, and circuit headers.

Circle No. 202 on Subscriber Service Card

FLEXIBLE COAXIAL CABLE—Andrew Corp. has published a comprehensive 16-page catalog on Neliax, the flexible airdielectric cable. The cable, introduced in 1952 by Andrew, has found universal acceptance in the RF field. The catalog describes in detail the improved electrical and mechanical characteristics of Heliax and accessories now available in 50, 75 and 100 ohms and in a range of sizes from ⅜ to 3⅛ inch.

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COMPUTER SIMULATOR—Technical Bulletin 60-F describes Model 2032 Memory System Exerciser, an automatic high-speed digital computer simulator that tests and evaluates complete memory systems over a wide range of operating parameters, is available from Rese Engineering, Inc. The bulletin emphasizes the machine's capability of simulating an exact computer environment for testing coincident-current and word-organized core, twister, rod, multi-aperatured and thin-film memories during development, prototype and production stages, and points out that address-to-address cycle times are continuously variable from three to 100-microseconds.

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CAPSCREW—A high-strength, stainless-steel, socket head capscrew family is reviewed in a four-page technical bulletin from Standard Pressed Steel Co. It gives both specification and performance data for the Unbrako KS 812, rated at an increased tensile strength of 125,000 psi minimum at room temperature, and for a wide temperature range of application from −300° to 800°F. A table of typical mechanical properties gives tensile, yield and shear strength, fatigue endurance and stress relaxation values for various temperatures.

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DISCRIMINATORS — An eight-page brochure describing phase-locked-loop discriminators for telemetry ground instrumentation is available from Electro-Mechanical Research, Inc. The brochure features a discussion of the phase-locked-loop characteristics and advantages in FM demonstration and describes and gives specifications of the EMR Models 167 transistorized and 165 vacuum tube phase-locked-loop discriminators.

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names in the news

RUEGER

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William F. Rueger: Named vice president and general counsel of Sylvania Electric Products, Inc., a subsidiary of GT&E Corp. He will also continue as secretary of the company.

Brig. Gen. Harold K. Kelley: Assigned as Assistant Deputy for Site Activation of Ballistic Systems Division, Air Force Systems Command, Los Angeles. Gen. Kelley formerly served in Washington, D.C. as Deputy for Construction, Directorate of Civil Engineering, Headquarters, USAF.

John K. Records: Appointed manager of newly-formed Instrumentation and Guidance Product Section in General Electric Co.'s Defense Systems Department, Syracuse, N.Y. Records joined the department when it was organized in 1958, as manager of the Military Systems Section.

George E. Chutka: Promoted to manager of Missile Industry Liaison, Minnesota Mining & Manufacturing Co., St. Paul.

W. C. Hobbs: Elected vice president of North American Aviation, Inc., Los Angeles. With NAA since 1943, he worked in labor relations, plant engineering and administrative positions before becoming assistant to the senior vice president-administration in 1956. He will continue in the latter position.

Dr. Maurice Goldhaber: Outstanding authority in nuclear and fundamental particle physics, appointed director of Brookhaven National Laboratory, L.I., N.Y. Dr. Goldhaber succeeds **Dr. L. J. Haworth,** who was appointed a member of the U.S. Atomic Energy Commission on April 15. In the interim, **Dr. G. F. Tape** has served as acting director; he will continue as deputy director under Dr. Goldhaber.

Dr. Ernest G. Brock: Appointed manager of Quantum Physics Laboratory, General Dynamics/Electronics' Research Division. Other appointments to the Research Division are: **Dr. Carl E. Drumheller,** manager of Physical Electronics Laboratory; **Dr. Gerald W. Sears,** manager of Molecular Physics Laboratory; **Dr. Hisao Yamada,** manager of Information Processes Laboratory.

Keith B. Banks: Former deputy chief of Air Defense Operations Division, office of Deputy Chief of Staff for Operations, Department of the Army, appointed programs department manager, Space Recovery Systems, Inc., El Segundo, Calif.

Col. Kirk R. Buchak, USA (ret.): Assumes management responsibilities for construction and installation of communications systems with Page Communications Engineers, Inc., Washington, D.C. Until his retirement from the Signal Corps, Buchak was Chief, Plant Engineering Division, for the Defense Communications Agency.

Gim H. Lee: Former production manager of tungsten and molybdenum, Wah Chang Corp., appointed vice president in charge of operations, Metallurgical International, Wallington, N.J.

William H. Long: Named manager of the Nuclear Materials and Propulsion Operation, General Electric's Flight Propulsion Laboratory, Cincinnati. Long formerly was manager of applications and contracts.

George M. Leitch: Former program manager of NASARR radar projects at North American Aviation's Autonetics Division, joins Aeronutronic Division, Ford Motor Co., as special assistant to general operations manager and acting manager of fabrication services of Electronics Operations.

Dr. Robert F. McAlevy, III.: Named consultant in field of solid propellant combustion at Malaker Laboratories, Inc., Mountainside, N.J. Dr. McAlevy previously was responsible for solid-propellant research projects at Princeton University's Aeronautical Engineering Dept.

Ole A. Sandven: Promoted to vice president and director of Physical Metallurgy Dept., Ilikon Corp., Natick, Mass. Before joining Ilikon, Sandven was a research metallurgist at Massachusetts Institute of Technology.

Alan D. Bailey: Joins Space Instrumentation Division, Technology Instrument Corp. of Acton, Acton, Mass., as senior electronic engineer. Earlier, Bailey was assistant professor in electronic research at Northeastern Univeristy.

Dr. Sidney K. Shear: Named director of research of Naval Warfare Analysis Group, the long-range studies division of the Operations Evaluation Group (OEG), Massachusetts Institute of Technology, effective Aug. 1. Dr. Shear replaces **Dr. Douglas L. Brooks,** who is taking leave for research at MIT's Earth Sciences Laboratory. Before joining OEG, Dr. Shear was a staff physicist with the Navy's Bureau of Ships and Bureau of Ordnance.

Maj. Gen. John A. Barclay, USA (ret.): Joins The Lionel Corp., Hillside, N.J., as vice president for research and development. Gen. Barclay recently retired as Deputy Commander, Ordnance Missile Command, Redstone Arsenal, Ala.

Alonzo B. Kight: With Borg-Warner since 1948, elected president of Borg-Warner International Corp., Chicago. **Charles W. Mason** appointed vice president and assistant to general manager; and **Frank J. Hoyne,** vice president-sales of Mechanics Universal Joint Division.

Stanley M. Smolensky: Appointed general manager of National Electronics Division, Washington, D.C. of Thiokol Chemical Corp. Formerly Smolensky was director of operations at Thiokol's Reaction Motors Division.

Dr. Samuel W. Levine: Appointed technical assistant to the president's office, Fairchild Camera and Instrument Corp., Syosset, N.Y. Dr. Levine will be succeeded by **Berthold Pollick** as director of engineering and research for the Defense Products Division.

Dr. Robert J. Wineman: Appointed director of the Boston Laboratory, Monsanto Research Corp., Everett, Mass. Dr. Wineman formerly was in the special projects department of the Research and Engineering Division.

Maj. Gen. John S. Guthrie: Former commanding general of the XIVth Army Corps., named a vice president of Motec Industries, Inc., Hopkins, Minn. Gen. Guthrie also will serve as director of the Molectronics, Motec Engineering and Mohawk Foundry & Forge Divisions.

Interconnection . . .

(Continued from page 36)

by the second diagram, the work of the interconnection engineers has markedly improved the battery cable system. Comparison of the initial cabling layout and the final production layout provides a vivid example of the improvements. The advantages of the improved system over the old one are:

—The complement of cable assemblies per system is decreased from 69 to 29.

— The number of cable assembly types is decreased from 12 to 2—with no degradation of operation.

—The weight of the system is decreased by approximately four tons.

—The direct cost per system is estimated to have been decreased by $20,000. The indirect cost (such as savings in spare cables, vehicles, storage space and manpower) is indeterminable for the quantity of systems to be produced.

—Operational flexibility is gained by having the minimum number of cables.

• **Prime contractors at fault**—During the Raytheon interconnection program, it was found that the cable and connector companies were very cooperative in attempts to improve their products.

Therefore, it would seem that most cabling problems are caused mainly by prime contractors who do not provide engineers to work with the cable and connector companies at the outset of the development program. These small companies need the guidance and overall system coordination that can only be provided by the prime.

However, it is not feasible to conduct a program of this nature for one engineering R&D model. The cable and connector companies cannot cooperate on small orders because of the high costs of manufacturing.

Under these circumstances, one adequate, low-cost possibility might be the "blown-jacket" type of construction, with a consequent possible degradation of field performance. Proper system design will minimize the changes required in the various units to incorporate quality cable assemblies when production contracts have been awarded. ⌗

Martin Receives Contracts For Pershing Production

THE MARTIN CO. has received two letter contracts totaling more than $70 million from the Army for continued development and production of the solid-fueled *Pershing* missile system. Detailed contracts are to be signed later.

Martin said one contract is for completion of *Pershing* test and development, which the company began in 1958. The other is for production of missiles for delivery to combat units. Production of the 100-300 mile missile is expected to begin as soon as a contract is signed, a spokesman for Martin said. ⌗

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America Still Wants to Know

ON SUNDAY, July 30, golfing enthusiasts viewing the PGA tournament on television missed little Jerry Barber's startling finish because the tourney was cut off the air to make way for the first of a new TV series entitled "All America Wants to Know."

Missiles or bombers? That was the question at issue and the star performer on the show was Gen. Curtis LeMay, U.S. Air Force Chief of Staff.

"Some people say manned bombers are obsolete!" read the newspaper ad in advance of the show. "Is this true? The experts in the panel shown above will get the facts by firing questions at General LeMay. Tune in! This nation's survival may depend on our current military strategy."

The panel consisted of these well-known critics of manned aircraft: Sen. Barry Goldwater, a general in the Air Force reserve; Marguerite Higgins, wife of an Air Force general; Mundy I. Peale, president of Republic Aviation; Robert Hotz, editor of *Aviation Week* magazine; Arthur Godfrey, longtime friend and hunting companion of Gen. LeMay.

The result, with one exception, was as expected. There was a dull non-controversial parroting of the Air Force position in favor of more manned aircraft. Whatever all America wanted to know about the bomber vs. missile question could just as well have been learned by a continued viewing of the PGA tournament.

The one startling moment in the show came in a vitriolic denunciation by Gen. LeMay and Sen. Goldwater of a *New York Times* article.

The conversation went like this:

In response to what seemed to be a planted question, Gen. LeMay denied the truth of the article, which said the Air Force was preparing a vigorous appeal to Congress to invest more heavily in manned aircraft in view of the Soviet air show.

Sen. Goldwater said that when he saw the article he "knew it was wrong" and made a personal check.

"This was irresponsible reporting of the best (sic) order . . ." the Arizona senator declared. "This is a figment of some man's imagination."

Gen. LeMay added: "I think that sums it up."

We frankly were astonished for we seemed to remember Gen. LeMay himself making just an appeal to Congress. Yet the statements by Gen. LeMay and Sen. Goldwater went unchallenged by the other members of the panel, including the very able Mr. Hotz, who certainly should have known better.

WE decided to do a little checking of our own. *The Times* article by Jack Raymond appeared in the city edition on July 13. On July 18, the Senate appropriations subcommittee was briefed on the Moscow air show and Gen. LeMay appeared before the committee. We carried his testimony in this magazine. However, we will quote what Mr. Hotz' magazine reported. *Aviation Week* said:

"Gen. LeMay flatly told the Senate appropriations subcommittee that more and better manned aircraft are needed now and in the foreseeable future. He asked for $448 million this year and $500 million in each of the 'three or four' subsequent years for the B-70, as well as $525 million this year for an additional wing of B-52s."

The magazine pointed out that Gen. LeMay had been called in to rebut earlier testimony by Deputy Defense Secretary Gilpatric that there is no immediate need for more money for manned aircraft.

What then was the irresponsible reporting of Mr. Raymond? We looked up the July 13 article in *The Times*. It said:

"The Air Force is preparing a vigorous appeal to Congress to invest more heavily in bombers and other manned aircraft in view of the impressive Soviet air show last Sunday.

"Qualified sources said Gen. Curtis E. LeMay, Chief of Staff of the Air Force, planned to urge greater outlays than the Administration had requested to develop the controversial B-70 supersonic high-altitude bomber.

"In addition, General LeMay was described as ready to appeal an Administration decision to cut off production of B-52 and B-58 bombers. . . ."

Pretty accurate figments! Who were the general and the Senator trying to mislead and why? Suspecting that the show might have been taped, we checked with CBS. The enormity of the crime then became even greater. The show had been taped on July 16 for release on July 30.

This then was the sequence of events: Mr. Raymond's article appeared on July 13. Gen. LeMay and Sen. Goldwater denounced it as irresponsible reporting on July 16. Gen. LeMay went before the Senate appropriations subcommittee just two days later, on July 18, and said exactly what Mr. Raymond said he was going to say.

Mr. Hotz can be excused for not challenging the remarks since, on July 16, Gen. LeMay had not yet made his appearance on the Hill. But why the heated denunciation of *The Times* article by the general and the senator?

Such duplicity is unnecessary. It only discredits the legitimate objectives of the Air Force. If more manned bombers are needed, we should have them. But through normal procedures, not through tactics such as these and not through dull propaganda exercises such as the loaded TV panel.

We think Gen. LeMay and Sen. Goldwater owe their viewing public an explanation. All America wants to know.

As the ad said, this nation's survival may depend on our current military strategy.

William J. Coughlin

RYAN RESEARCH VEHICLE SPEARHEADS FLEX WING APPLICATIONS

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Ryan Flex Wing enables helicopters to tow several times the cargo or fuel they can carry

Ryan has received several contracts from NASA and the military services to explore and develop the more promising Flex Wing applications. Pioneering an entirely new concept, such as Flex Wing, is typical of Ryan's Space Age capabilities.

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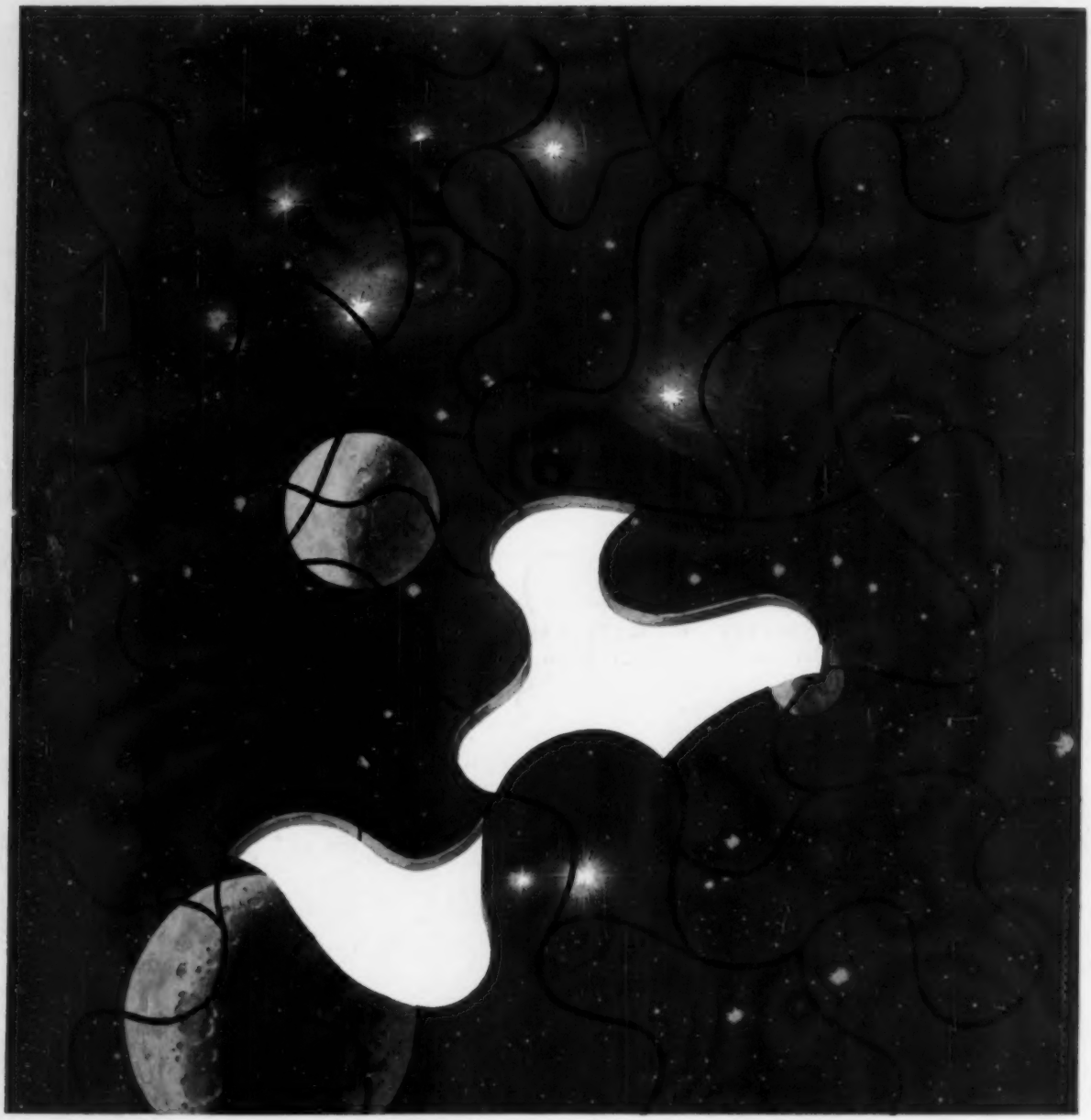

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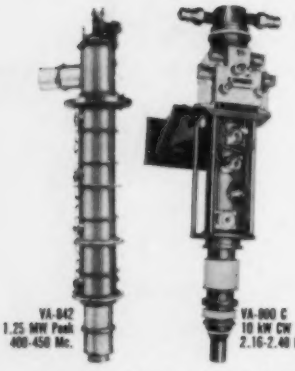

Man will soon step into space. But he must know more about radiation belts, the solar system, and other phenomena before he can travel to these alien worlds.

There are several solutions to this celestial jigsaw puzzle. Explorer satellites. Telescopes. Radar astronomy, where microwave energy is bounced against objects in space, to reveal their nature.

Varian klystrons make important contributions to radar astronomy. Two VA-842 tubes will power the world's largest radar telescope, in Puerto Rico. And a VA-800C klystron drives a JPL* transmitter at Goldstone, Calif., seeking out the secrets of Venus. To know more of Varian's power klystron capability, write Tube Division.

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